



ProQR R&D DAY

March 14, New York



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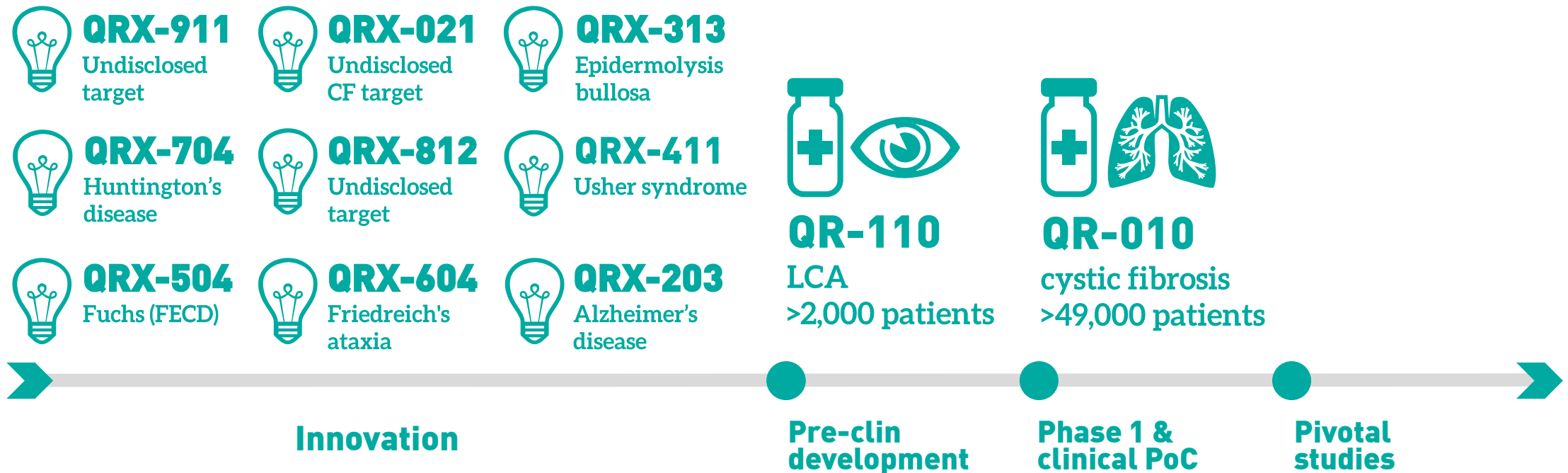
Forward looking statements

This presentation contains forward-looking statements that involve substantial risks and uncertainties. All statements, other than statements of historical facts, contained in this presentation, including statements regarding our strategy, future operations, future pre-clinical and clinical trial plans, future financial position, future revenues, projected costs, prospects, plans and objectives of management, are forward-looking statements. The words “aim,” “anticipate,” “believe,” “estimate,” “expect,” “intend,” “may,” “plan,” “predict,” “project,” “target,” “potential,” “will,” “would,” “could,” “should,” “continue,” and similar expressions are intended to identify forward-looking statements, although not all forward-looking statements contain these identifying words.

Forward-looking statements represent our management’s beliefs and assumptions only as of the date of this presentation. We may not actually achieve the plans, intentions or expectations disclosed in our forward-looking statements, and you should not place undue reliance on our forward-looking statements. Actual

results or events could differ materially from the plans, intentions and expectations disclosed in the forward-looking statements we make. The forward-looking statements contained in this presentation reflect our current views with respect to future events, and we assume no obligation to update any forward-looking statements except as required by applicable law. These forward-looking statements are subject to a number of risks, uncertainties and assumptions, including those that may be described in greater detail in the Registration Statement on Form F-1 (including the prospectus) that we have filed with the U.S. Securities and Exchange Commission. We have included important factors in the cautionary statements included in that prospectus, particularly in the Risk Factors section, that we believe could cause actual results or events to differ materially from the forward-looking statements that we make.

Research and development pipeline



ProQR



QR-010 for cystic fibrosis

RNA repair of cystic fibrosis $\Delta F508$

ssRNA oligonucleotides to improve the lives of patients with severe genetic disease

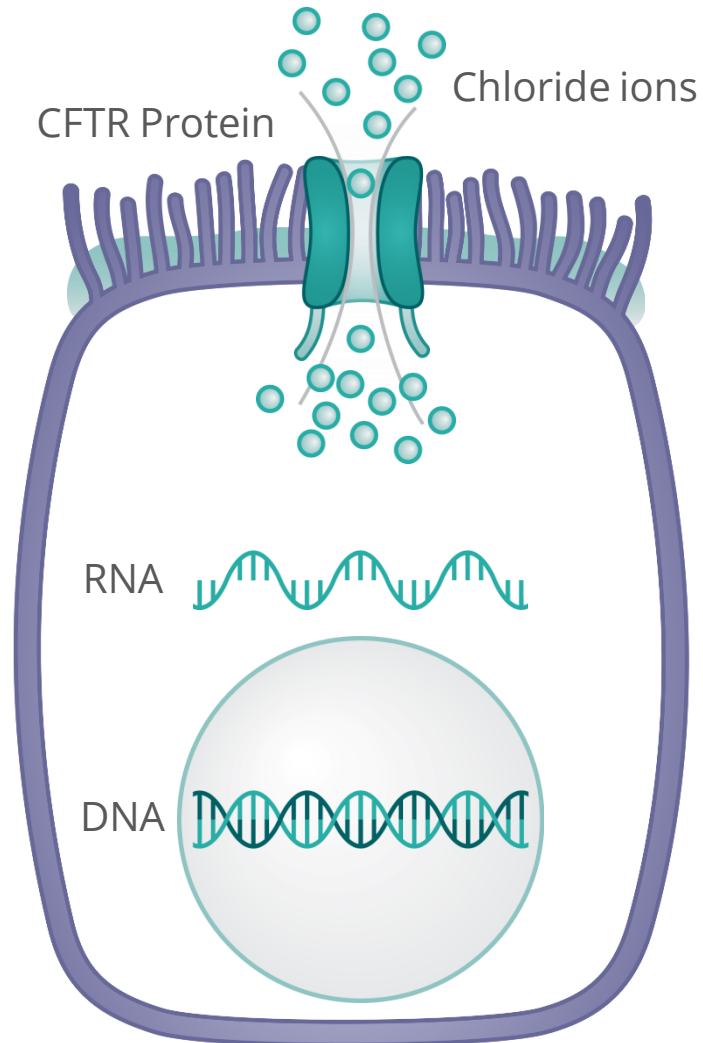
- All molecules that you will hear about today are ssRNA antisense molecules
- They do not all work via the same mechanism
- All hold the promise of restoring protein function
- ssRNA molecules are chemically modified – no vectors or envelopes
- Manufacturing is easy; cost of goods is low
- ProQR has exclusive IP

QR-010: ProQR's lead molecule, now in clinical development for CF

- QR-010 is a 33 mer chemically modified ss antisense RNA oligonucleotide
- Demonstrated to restore CFTR function in 2 *in vitro* models and 2 *in vivo* preclinical models
- Approach is unique
- Promise of gene therapy without the barriers
- Inhaled delivery with demonstrated uptake to the airways of the lung and delivery to extrapulmonary organs affected by CF

QR-010 for cystic fibrosis

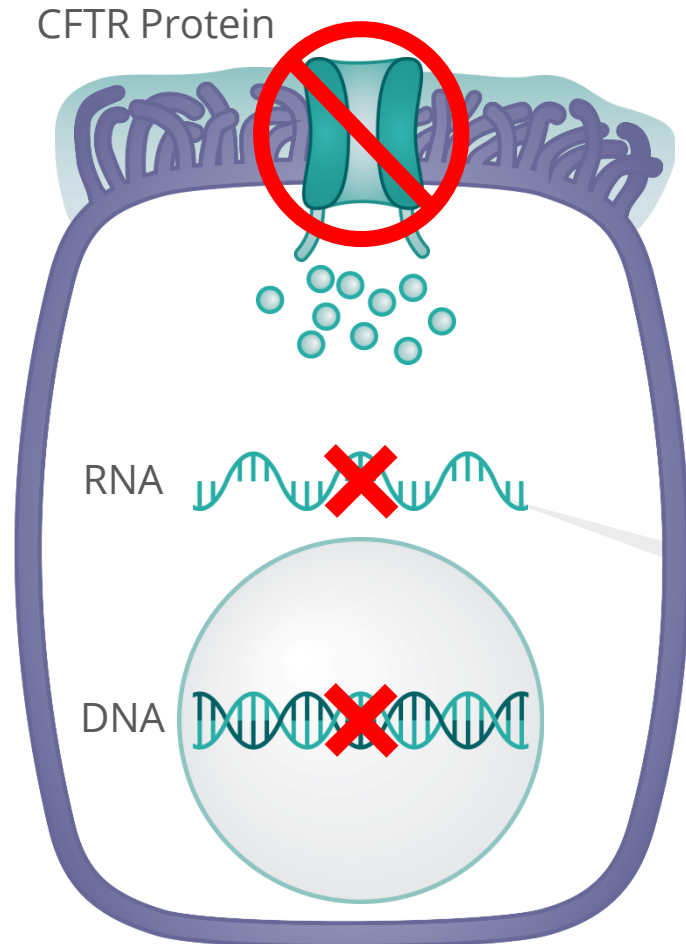
Focus on CFTR function



In wild-type cells
CFTR protein
reaches the
membrane

QR-010 for cystic fibrosis

Focus on CFTR function

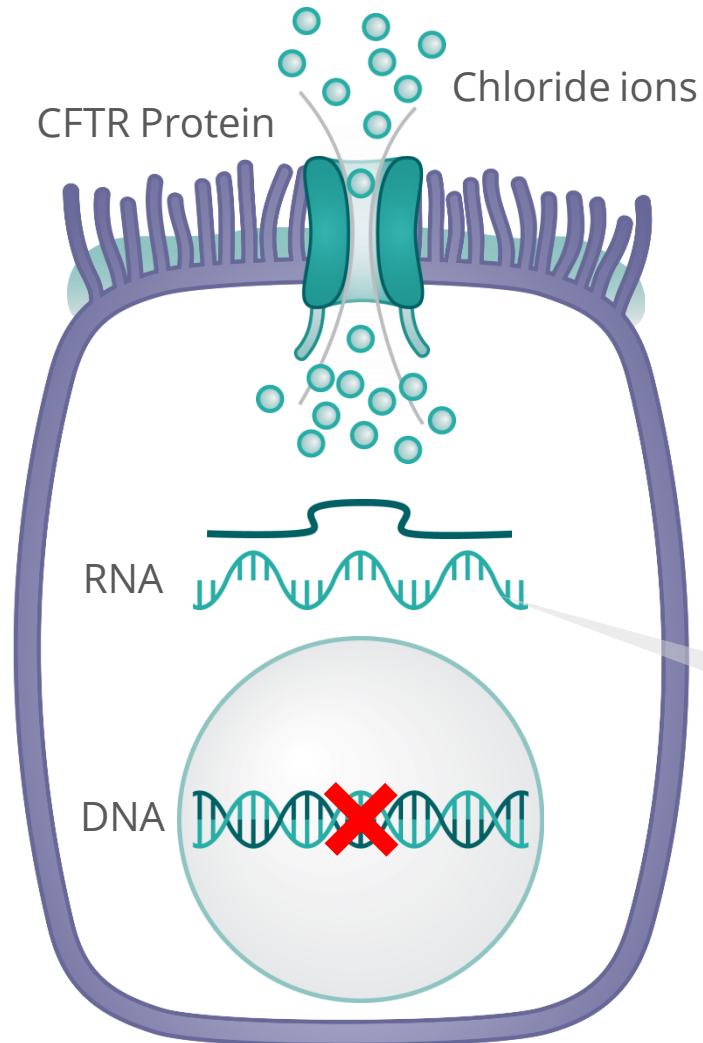


In Cystic Fibrosis cells CFTR protein does not reach the membrane

AUC AU~~UUU~~ GGU GUU

QR-010 for cystic fibrosis

Focus on CFTR function



PNAS

Reversal of cystic fibrosis phenotype in a cultured $\Delta 508$ cystic fibrosis transmembrane conductance regulator cell line by oligonucleotide insertion

Paul C. Zamecnik*, Malay K. Raychowdhury*, David R. Tabatadze, and Horacio F. Cantiello

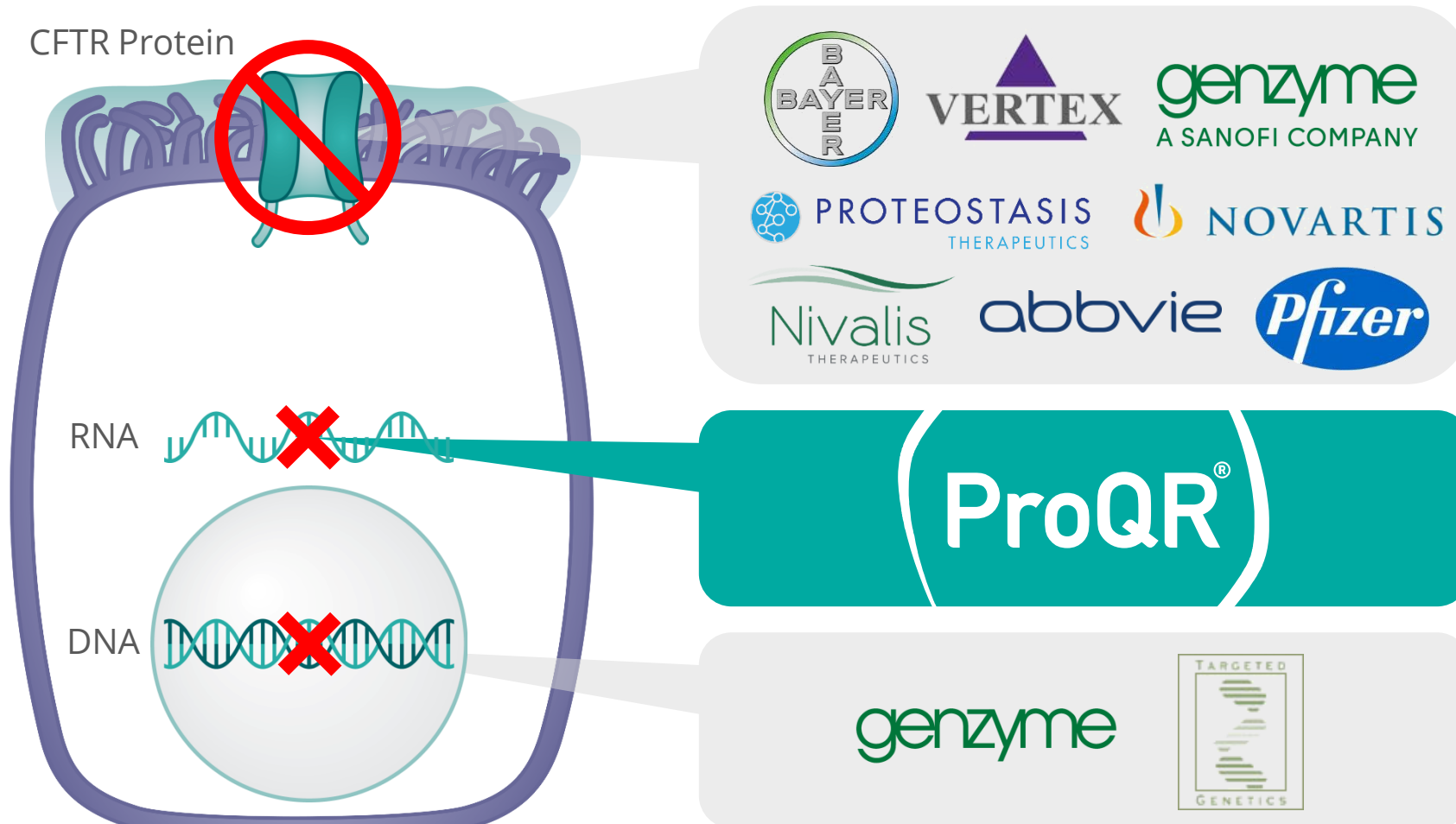
QR-010

$\Delta F508$

AUC AUC UUU GGU GUU

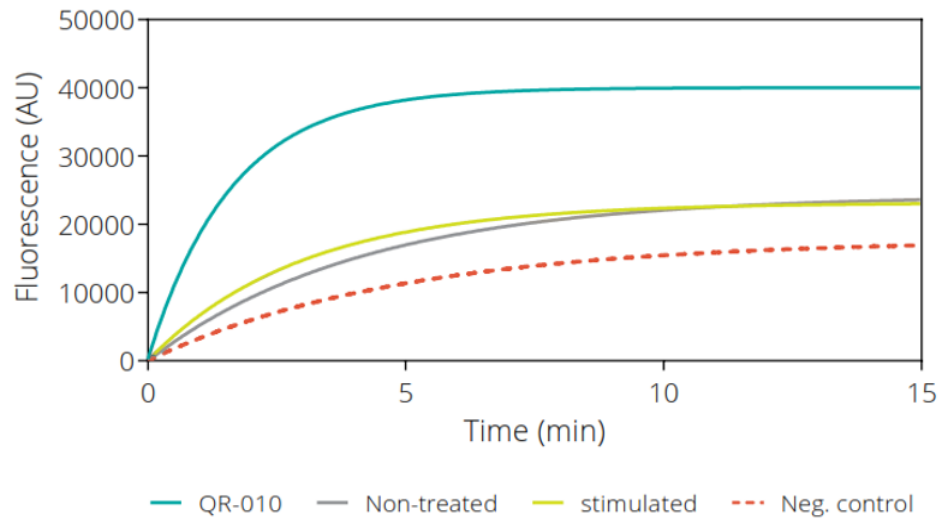
QR-010 for cystic fibrosis

Focus on CFTR function

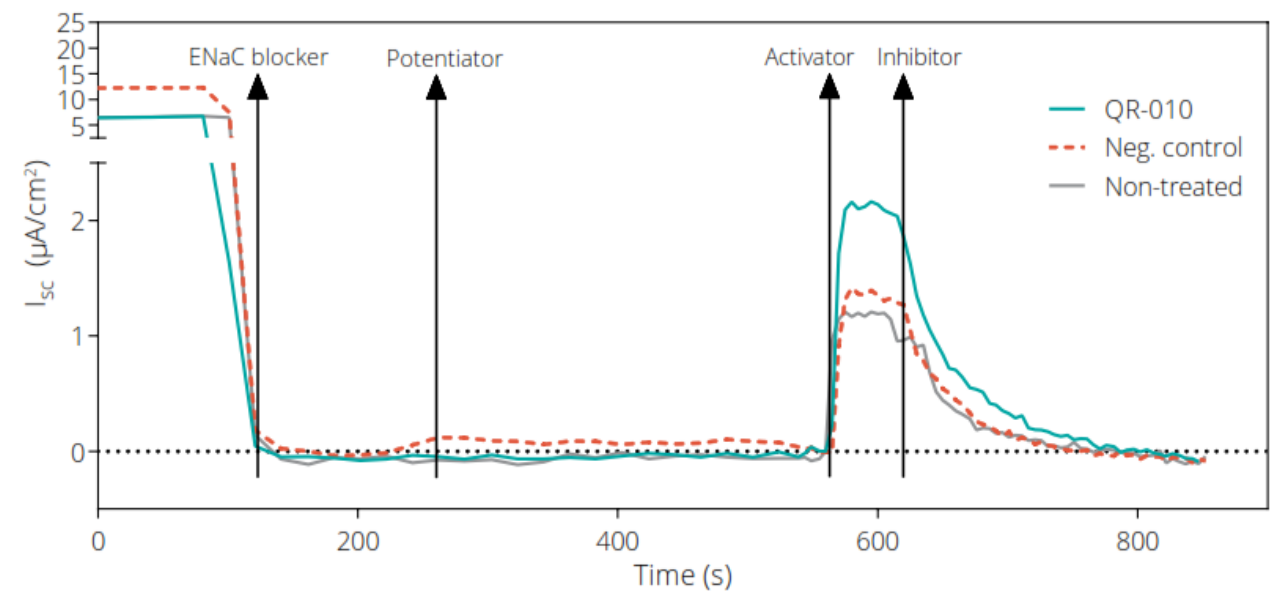


QR-010: Demonstrated increase in CFTR activity in two *in vitro* assays

MQAE Assay [CF PAC1 cells]



Ussing Chamber assay [primary HBE]



QR-010 increases CFTR activity in two *in vivo* assays

Δ F508 mouse model

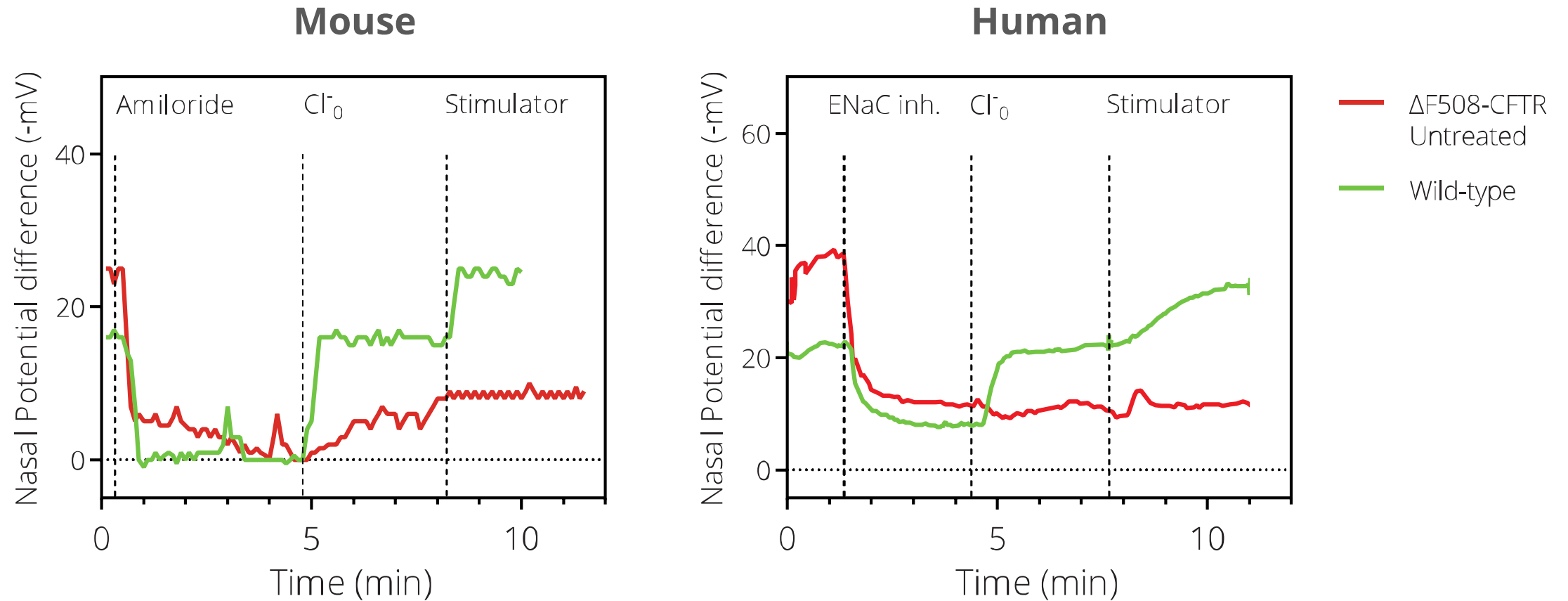
- Exact same mutation as in humans
- QR-010 used in mice and humans

Two independent functional assays

- Nasal potential difference (NPD) – diagnostic test for CF in humans
- Saliva secretion assay – specific mouse study that is a surrogate for the human sweat chloride test, another diagnostic test for CF in humans

QR-010 dependent restoration of CFTR protein function

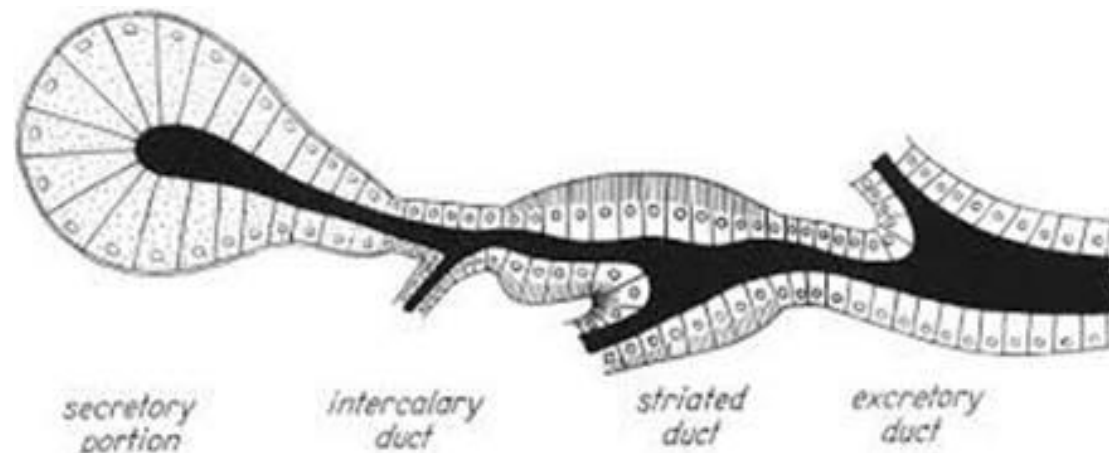
Background: NPD tracing interpretation



Methods Mol Biol. 2011; 741: 69-86.

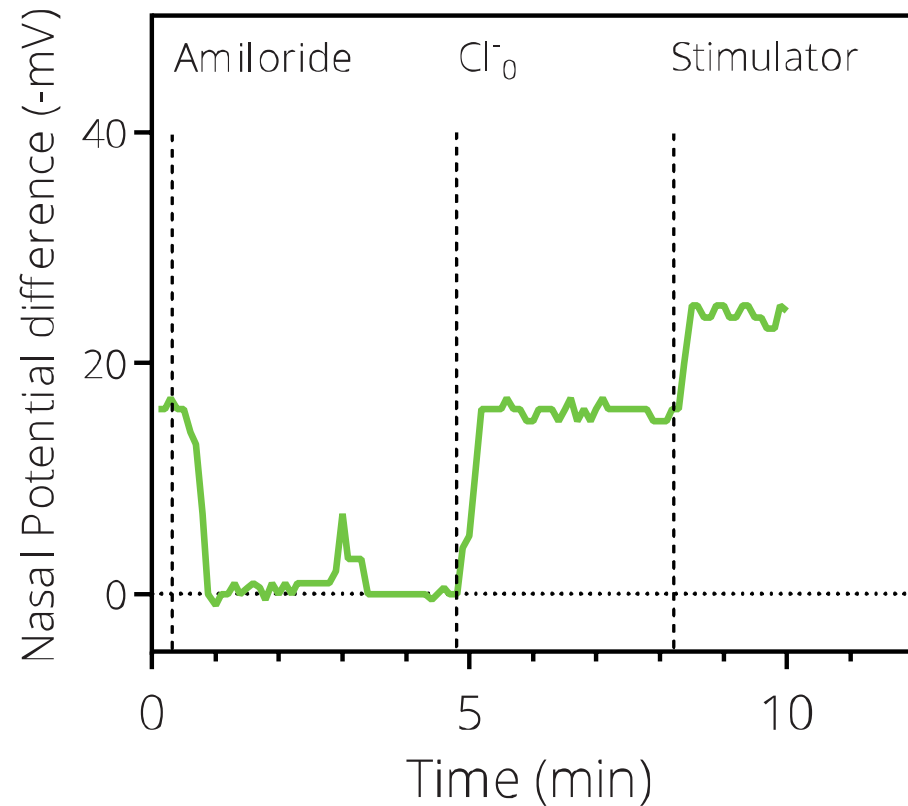
Background: Saliva Secretion Assay

- Similar to sweat chloride test in humans
- Saliva glands of female mice are highly dependent on CFTR to produce saliva

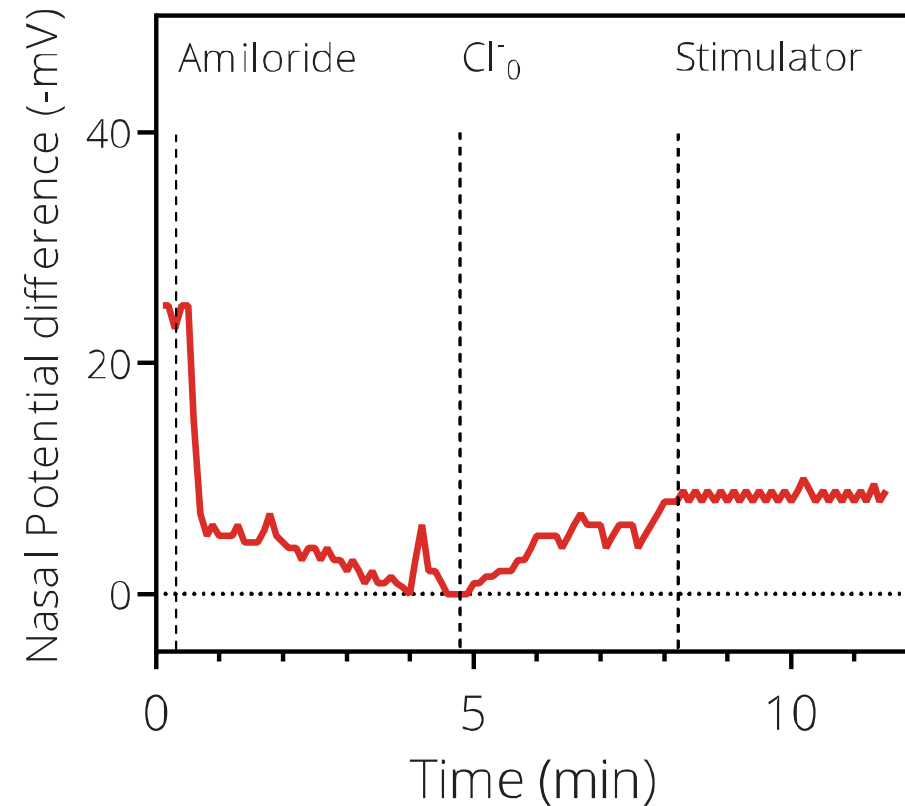


QR-010 increases CFTR activity as demonstrated by mouse NPD

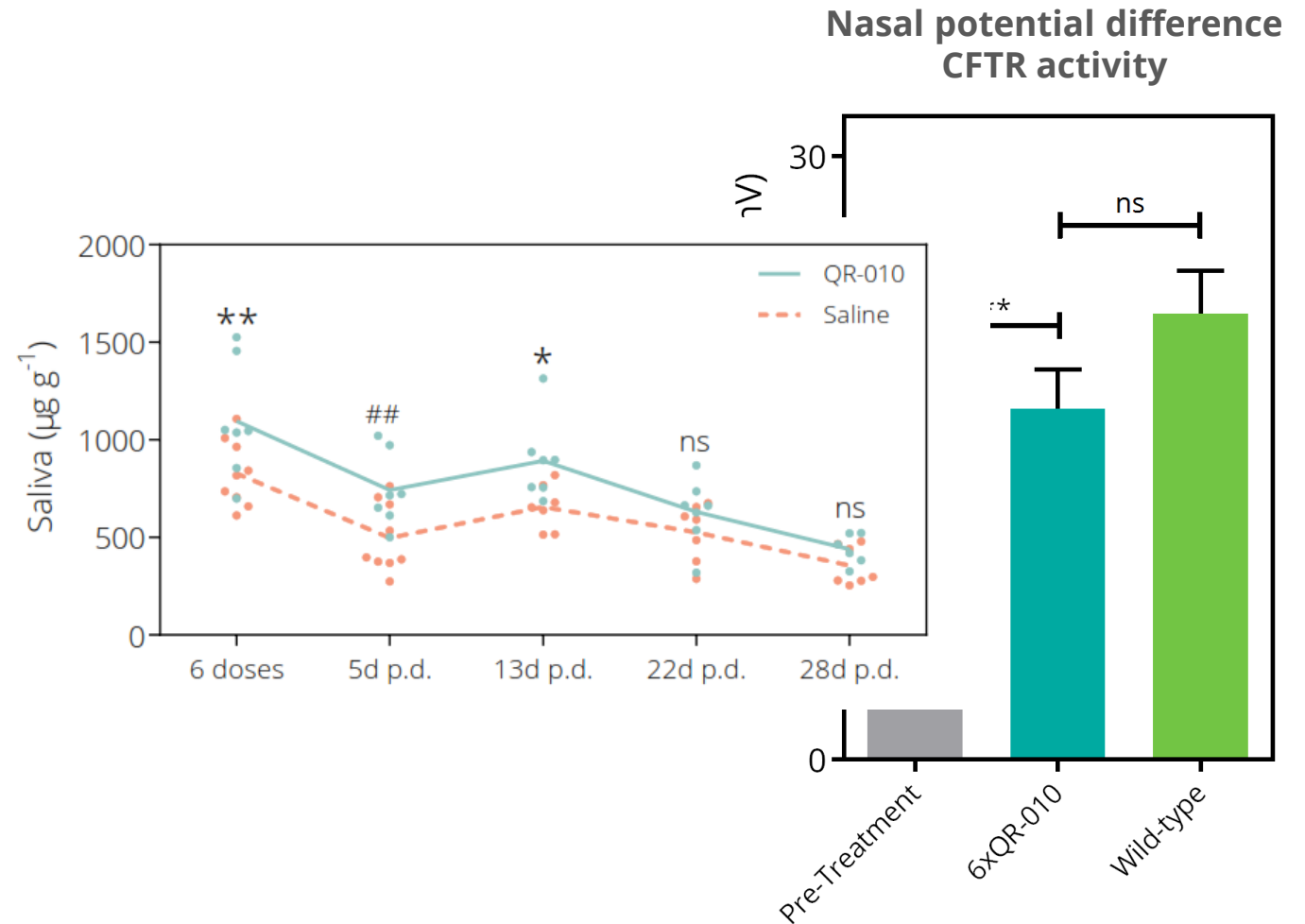
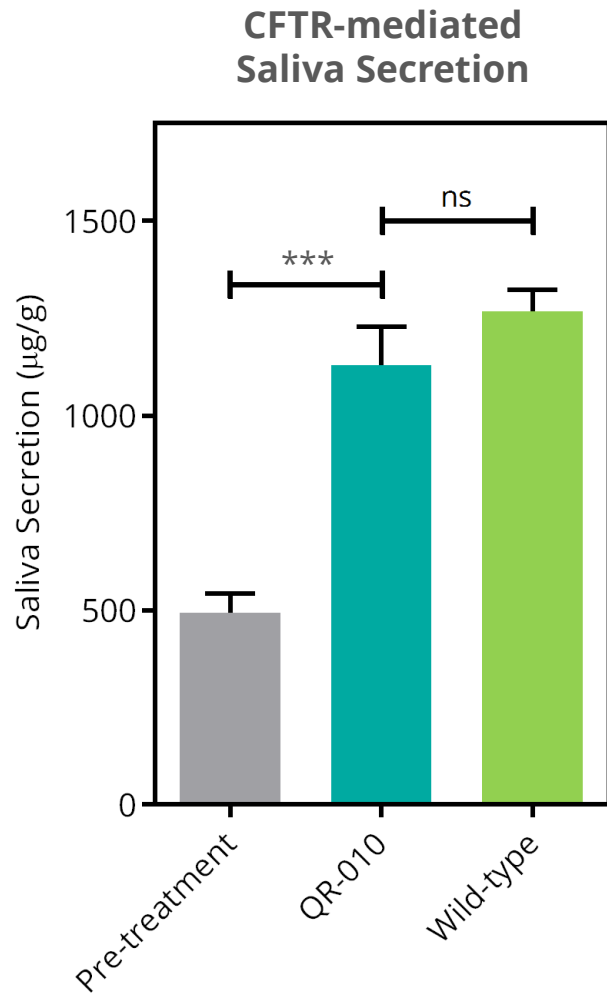
Wild-type mouse



$\Delta F508$ -CFTR mouse
Untreated

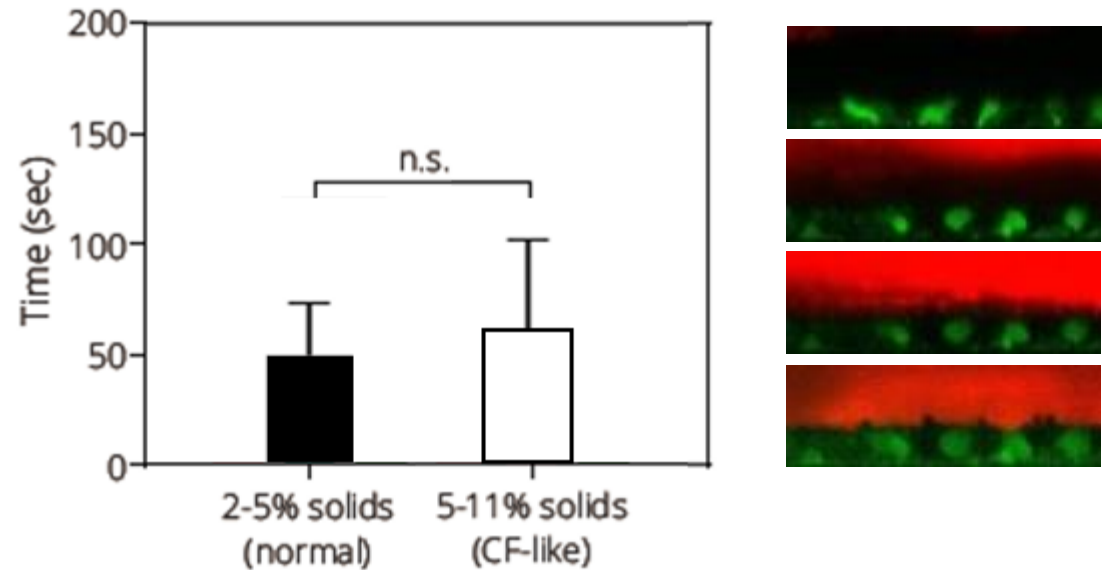


QR-010 increases CFTR activity in the saliva secretion assay

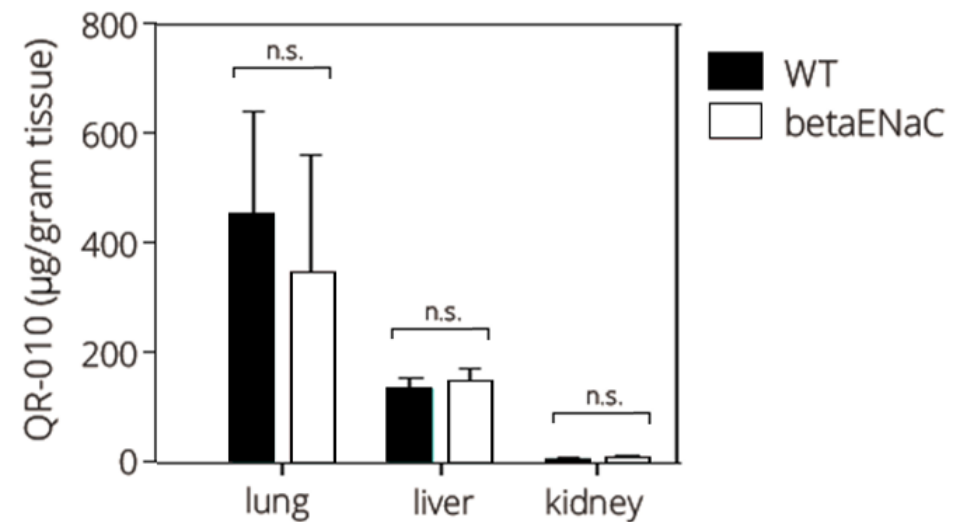


QR-010: aerosol gets through mucus and remains stable

QR-010 moves through sputum regardless of solutes



QR-010 is taken up by cells regardless of mucus



Additional studies:

- Stable in the presence of proteases
- Stable in the presence of CF standard of care inhaled medications
- Aerosol is 3-5 micron: optimized for small and medium airways

QR-010: Clinical Trials

Phase 1b Safety and Tolerability study

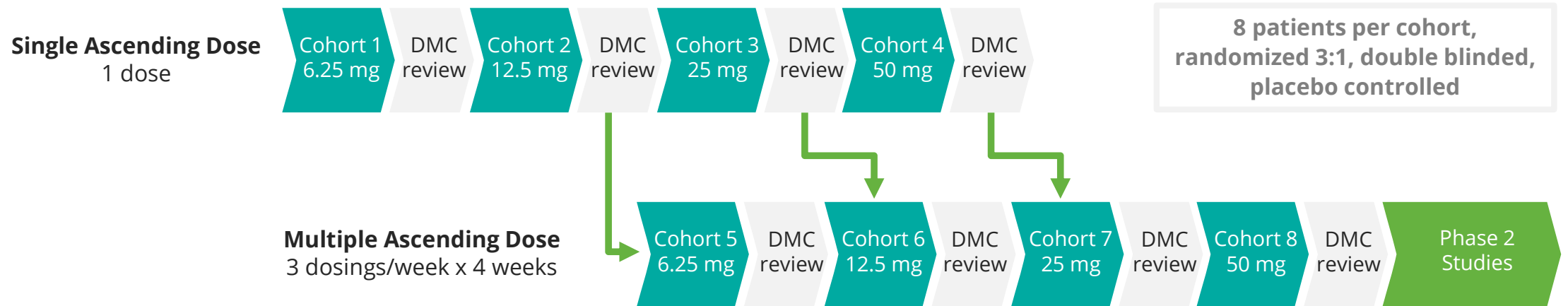
- QR-010 delivered via inhalation
- 64 homozygous $\Delta F508$ patients (> 18 yrs)
- First development study

Nasal potential difference proof-of-concept study

- QR-010 delivered topically to nasal passages
- 16 patients total, 8 homozygous $\Delta F508$ patients and 8 compound heterozygous patients (>18 yrs)
- Proof-of-concept study

QR-010: PQ-010-001

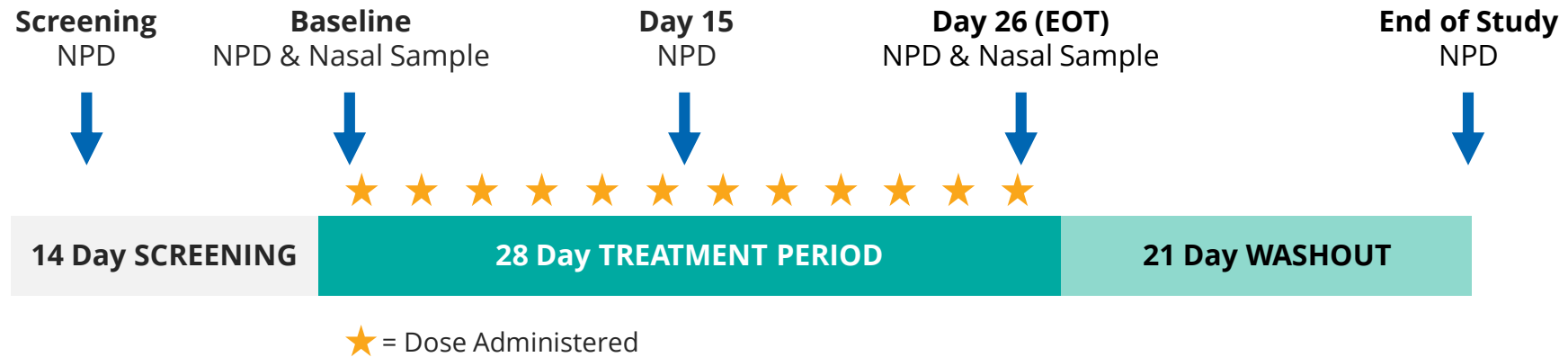
Phase 1b Safety and Tolerability



- 64 homozygous $\Delta F508$ CF patients (>18yrs)
- Inhalation through Pari eFlow nebulizer
- Participating sites: 20 sites in EU (CTN) and US (TDN)
- Endpoints:
 - Safety, tolerability and pharmacokinetics
 - Exploratory efficacy (FEV1, CFQ-R, weight gain, sweat chloride)

QR-010: PQ-010-002

Proof-of-Concept Study



- Proof of Concept Nasal Potential Difference (NPD) study in Δ F508 CF patients >18yr
- 8 homozygous and 8 compound heterozygous patients in adaptive design
- Open-label case-controlled study
- Multiple dose design: 12 doses (3 per week x 4 weeks)
- Local dosing in the nose
- Up to 5 participating sites in EU (CTN) and US (TDN) all experienced NPD reference sites
- Endpoints:
 - NPD
 - Sweat chloride

QR-010: ProQR's lead molecule, now in clinical development for CF

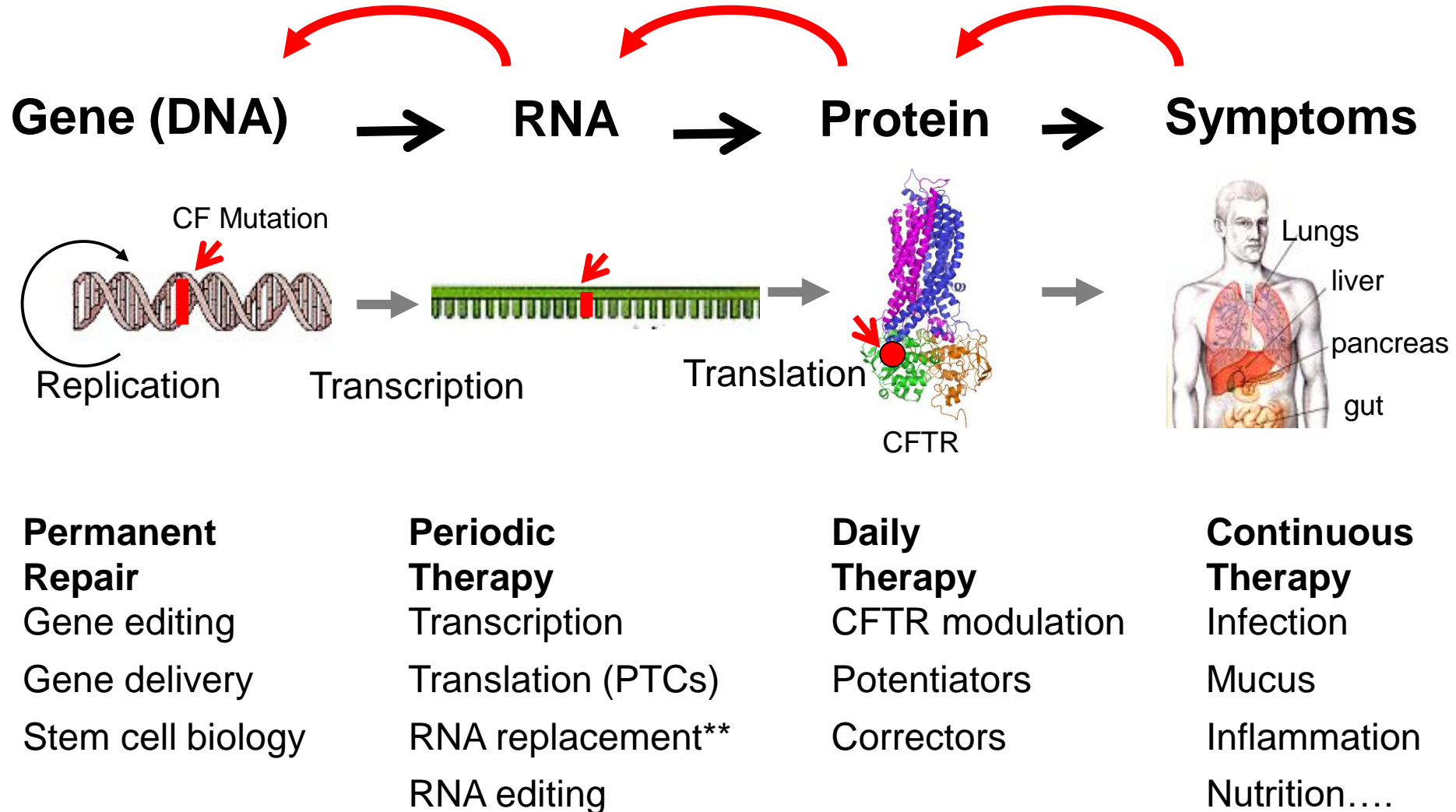
- On-going preclinical work continues to demonstrate consistent increase in CFTR function
- Two clinical trials actively enrolling
 - Safety and tolerability
 - NPD proof-of-concept
- No similar approach to correct CFTR function
- Strong IP



Can we do better?

ROBERT J. BEALL, PH.D.
*Former President and CEO
Cystic Fibrosis Foundation*

Our Goal: A Lifelong Cure For All CF Patients

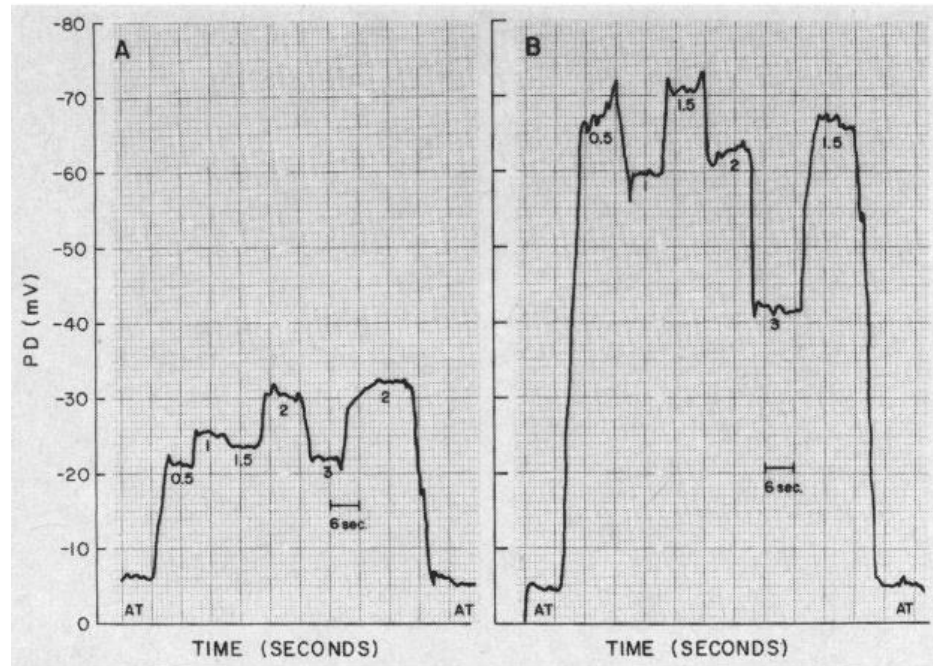


The Three Most Important Observations in CF Research History

1. Abnormal Potential Difference in CF Airways

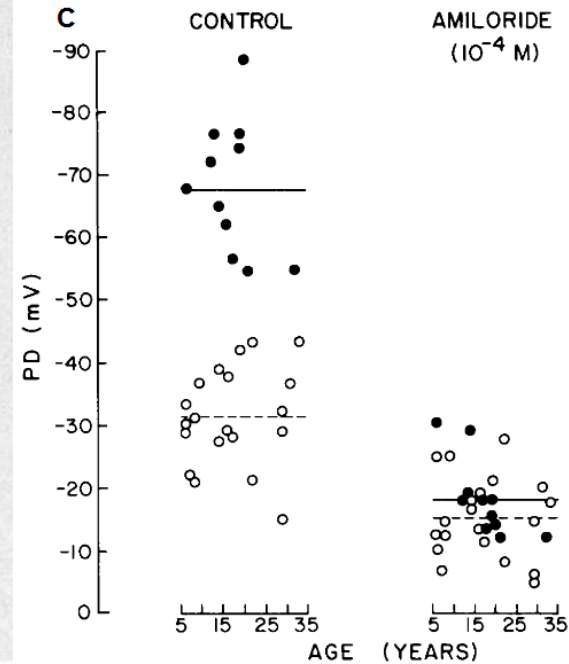


Raised Transepithelial Potential Difference (PD) and Amiloride Inhibition of PD in CF vs Normal Subjects: Evidence for an Intrinsic Defect in CF Epithelial Ion Transport

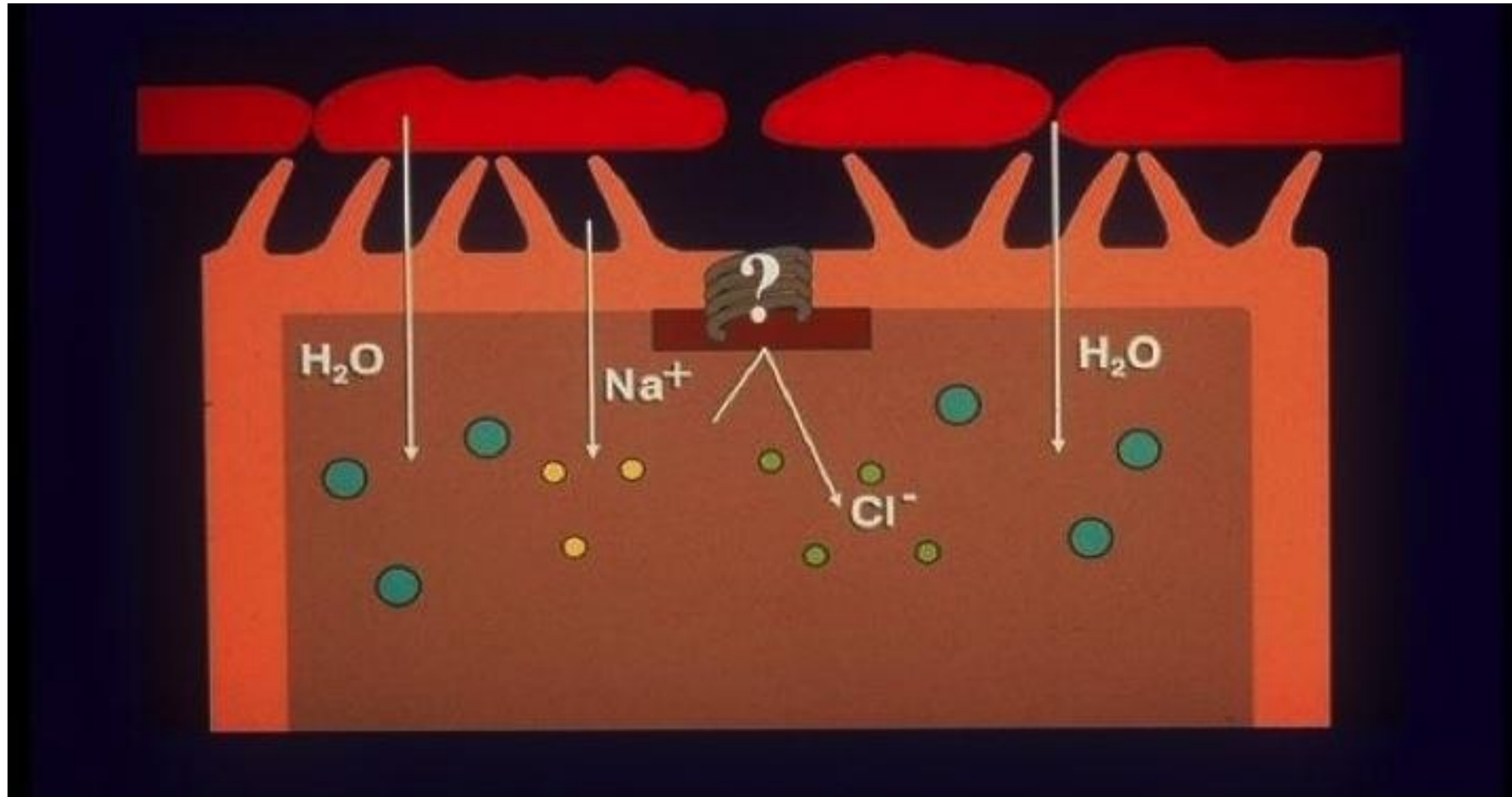


Normal Subjects

CF Subjects



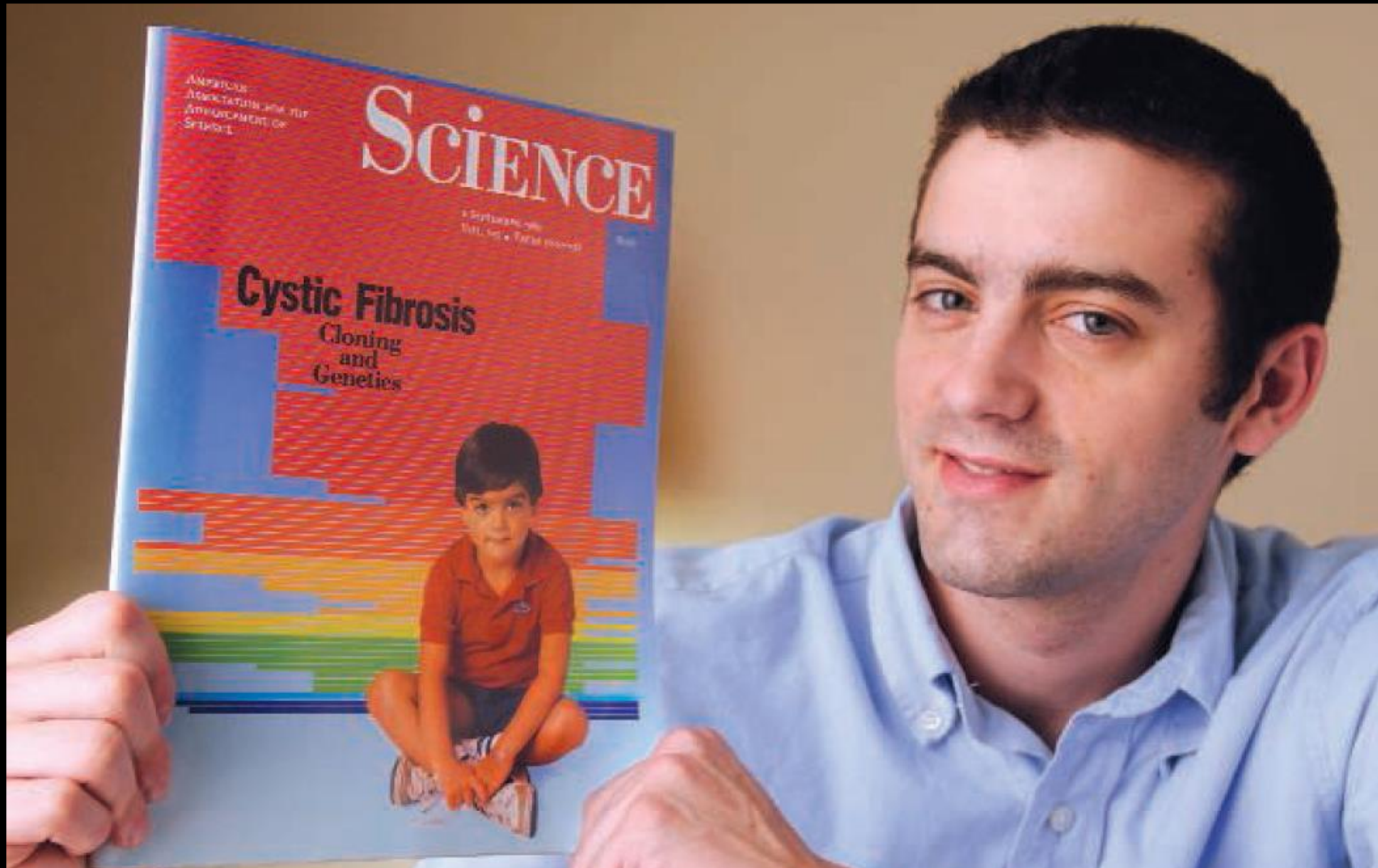
Amiloride Inhibition of PD (Na⁺ transport) in CF (●) vs Normal (○) subjects



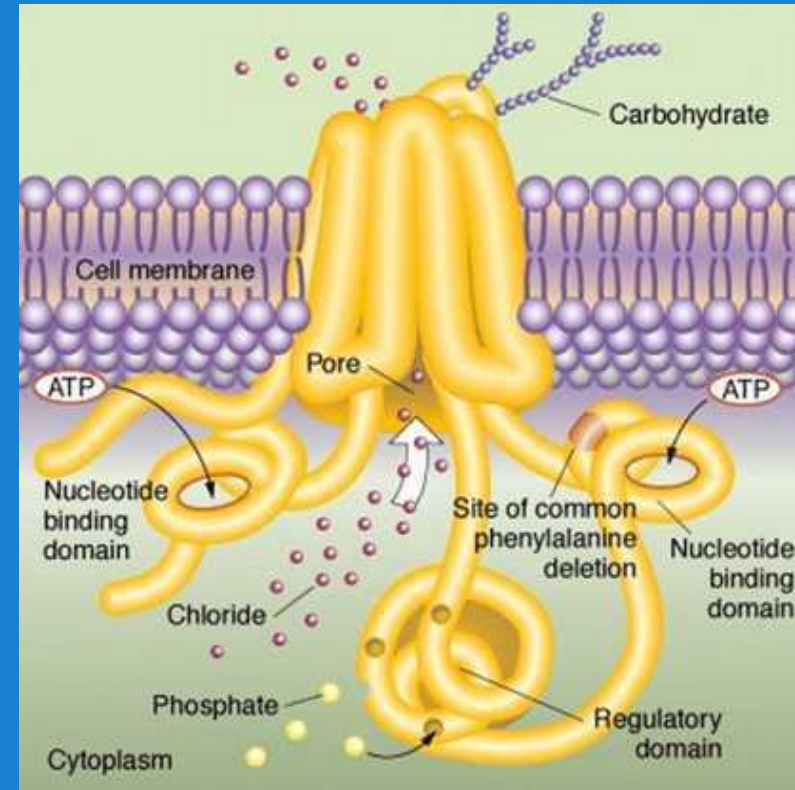
The Three Most Important Observations in CF Research History

1. Abnormal Potential Difference in CF Airways
- 2. Discovery of CF Gene in 1989**

Discovery of CF Gene 1989



- Acts as a Chloride Channel
- Controls Salt and Water Balance in the Airways



The Three Most Important Observations in CF Research History

1. Abnormal Potential Difference in CF Airways
2. Discovery of CF Gene in 1989
3. **Small Molecules (Kalydeco) Can Partially Correct the CFTR Defect in Cystic Fibrosis Patients**

2012 – FDA Approves Ivacaftor

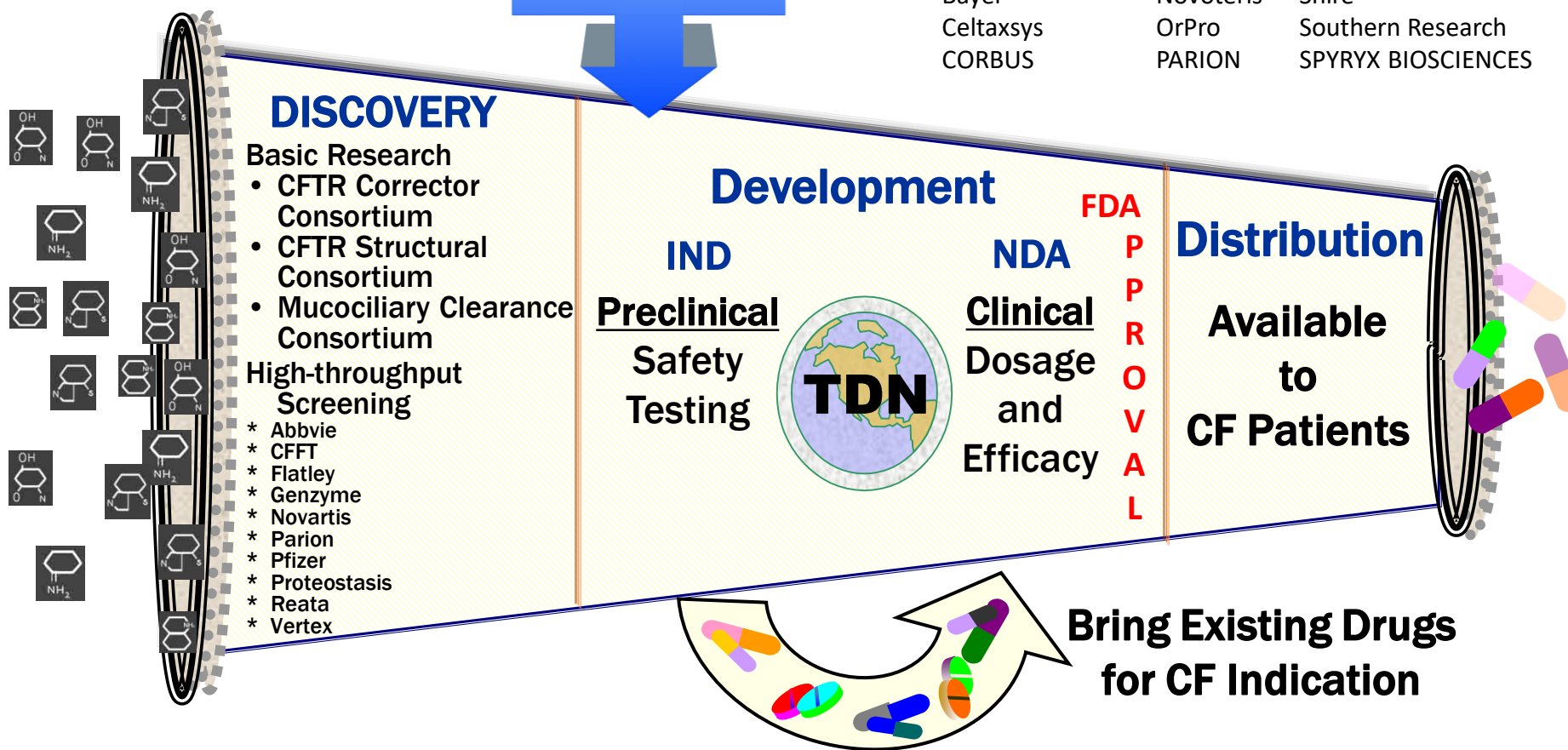


Therapeutics Development Program

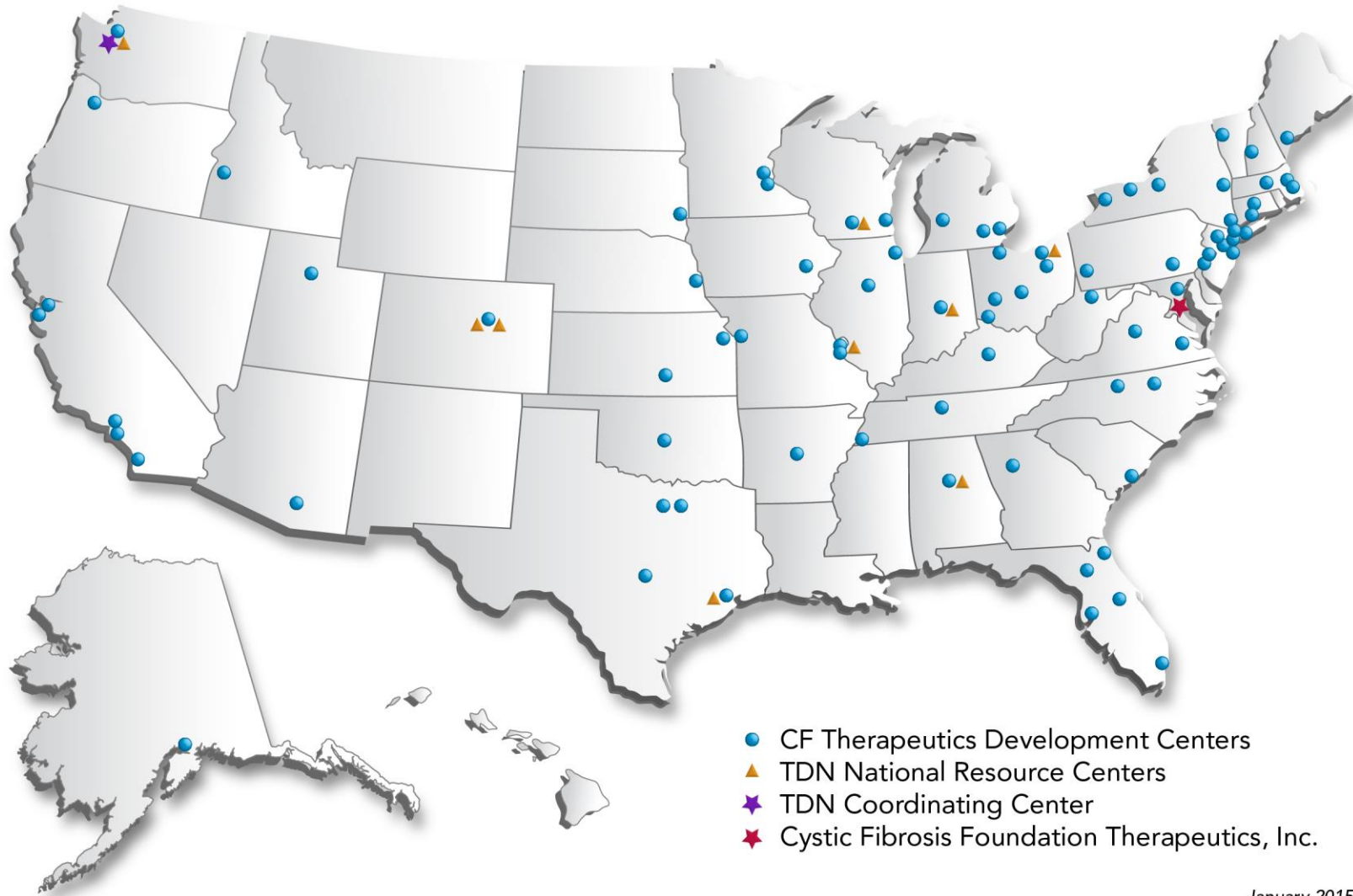
Therapeutics
Development
Awards

Our Biotech Collaborators

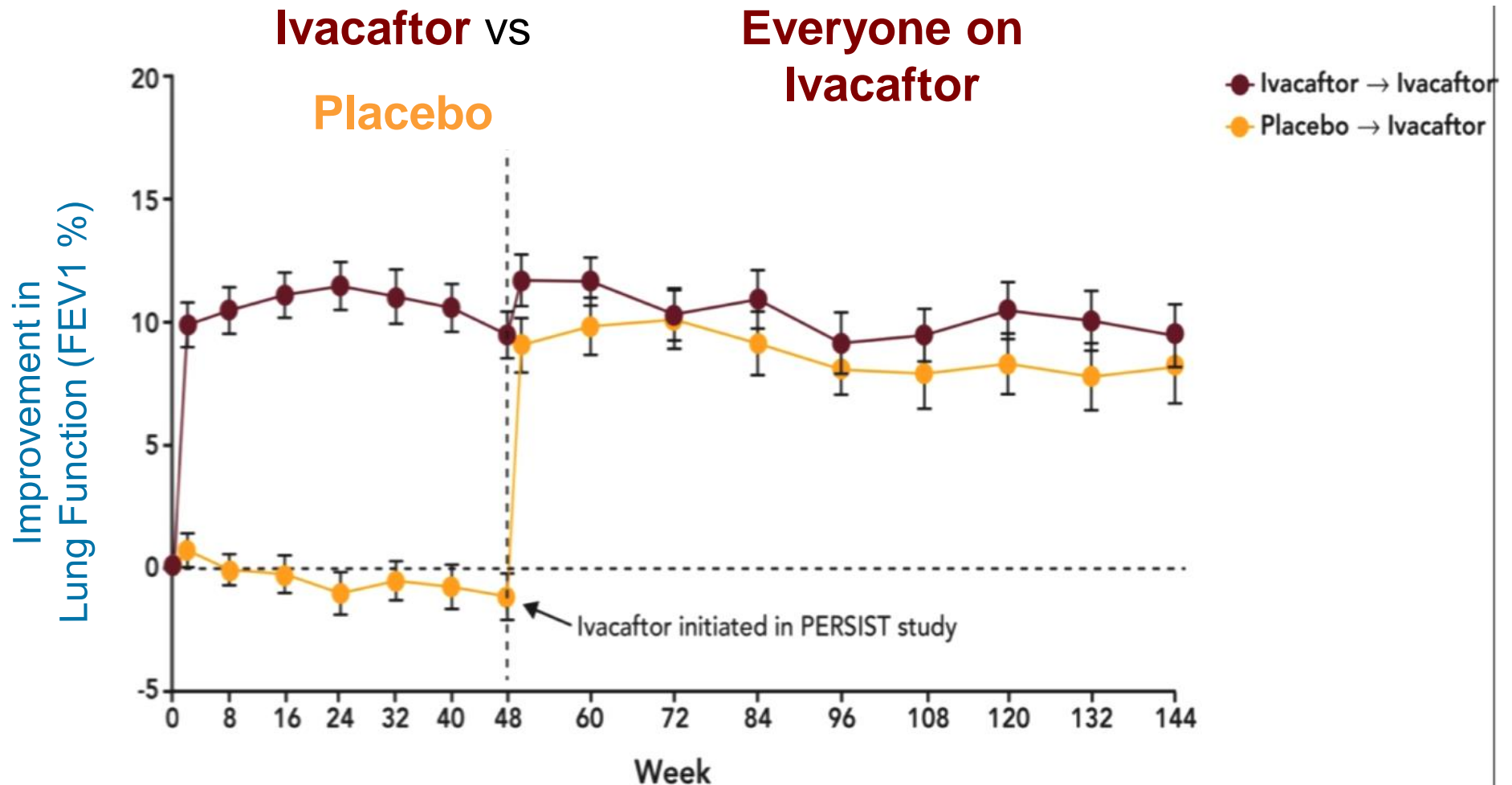
Alcresta	CURx	POLYPHOR
AlgiPharma	IONIS	ProQR
Anthera	Nivalis	Savara
Bayer	Novoteris	Shire
Celtaxsys	OrPro	Southern Research
CORBUS	PARION	SPYRYX BIOSCIENCES



Therapeutics Development Network

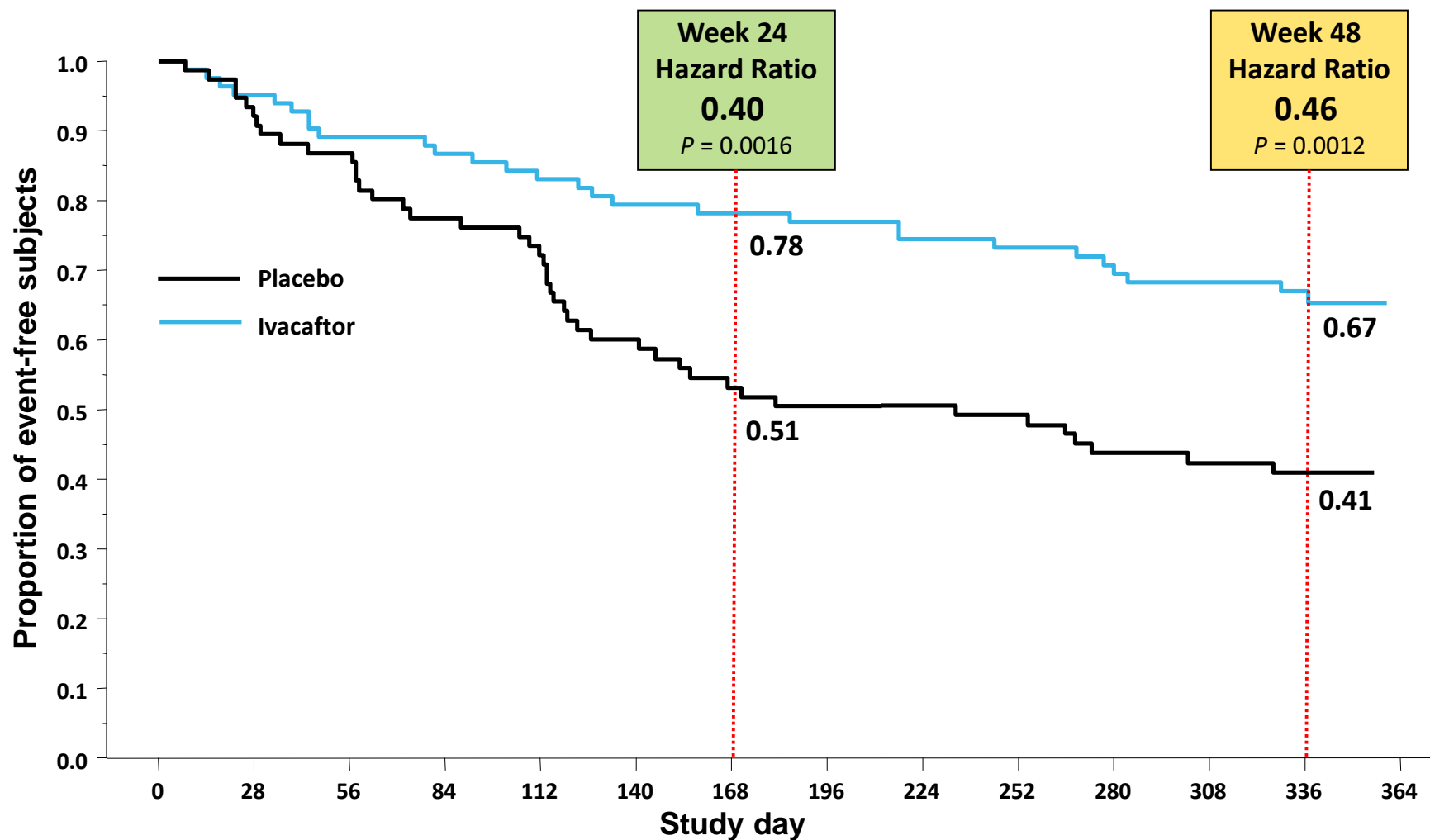


Ivacaftor Improved FEV₁: Most Important Proof of Concept in CF History



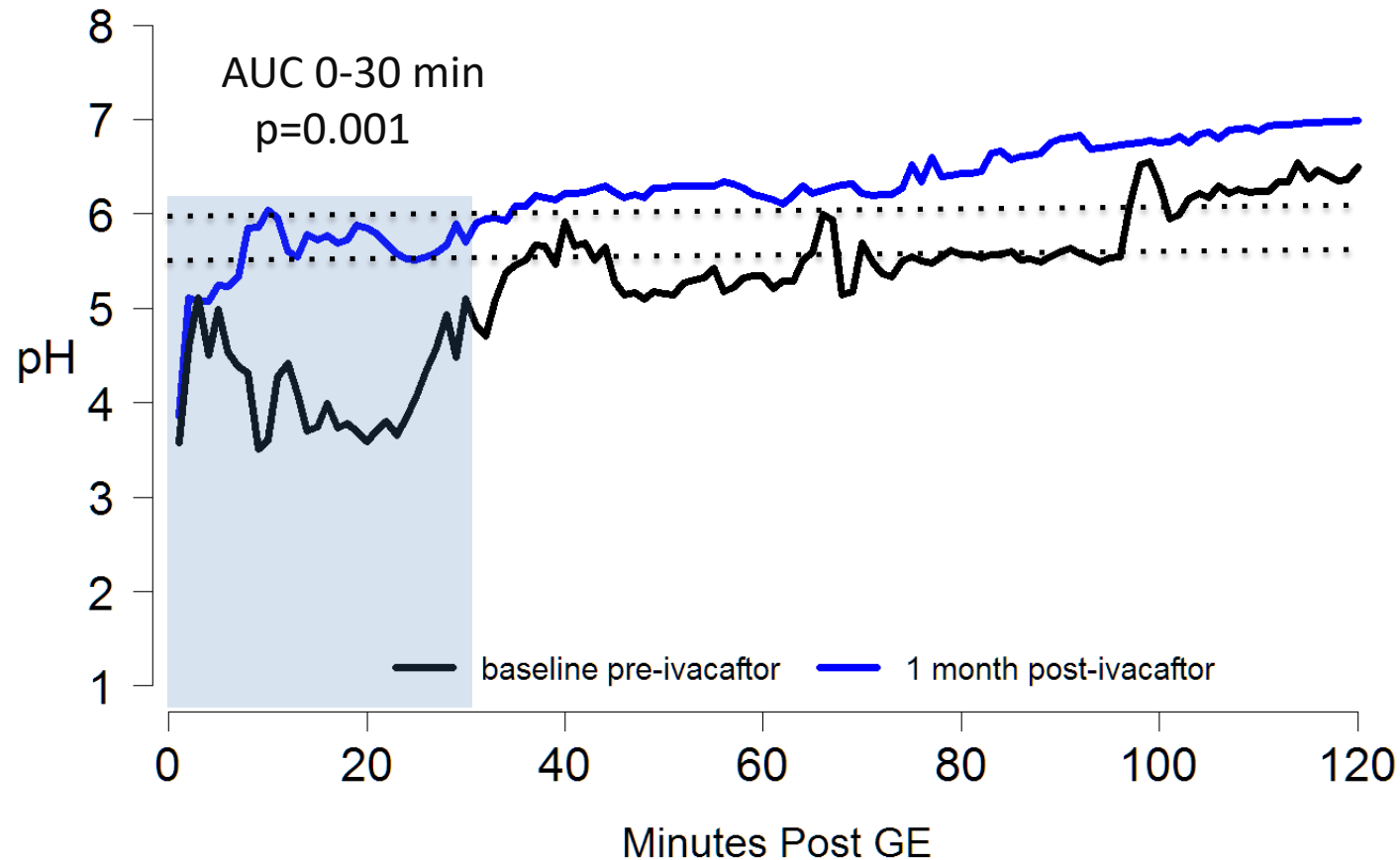
Time-to-First Pulmonary Exacerbation

Modified Fuchs' criteria

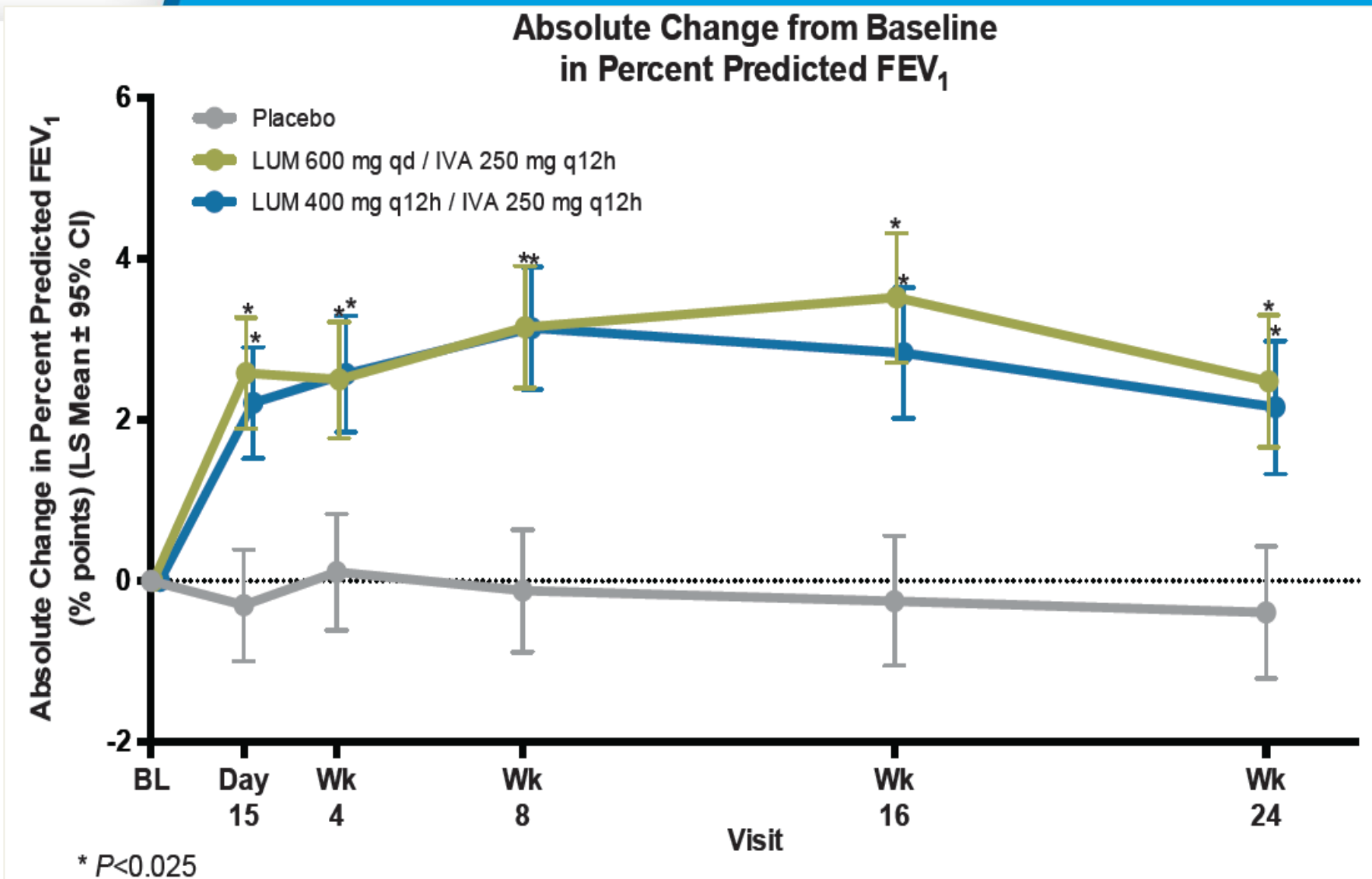


Key secondary endpoint in gold

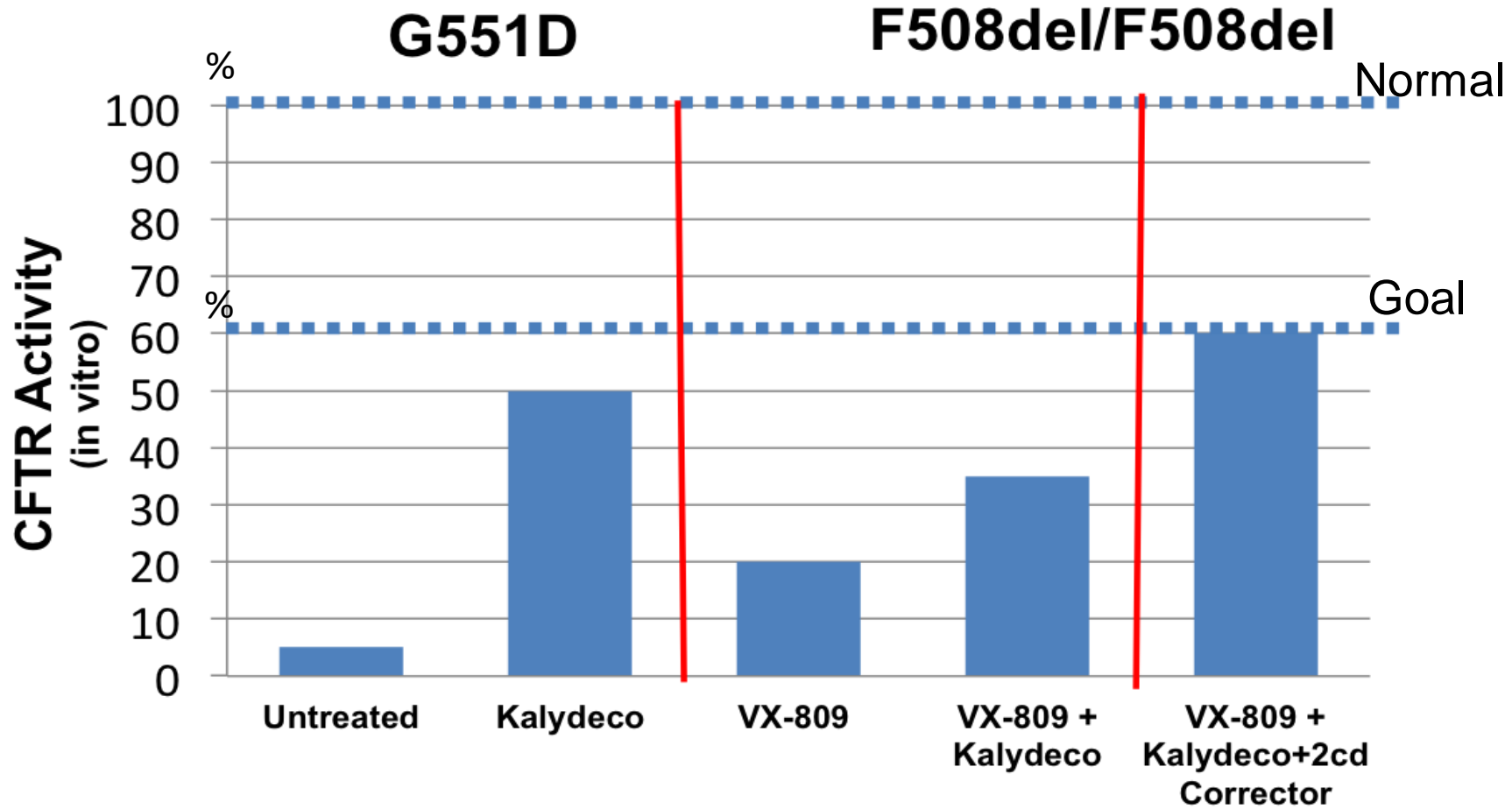
Effect of Ivacaftor on Small Bowel pH

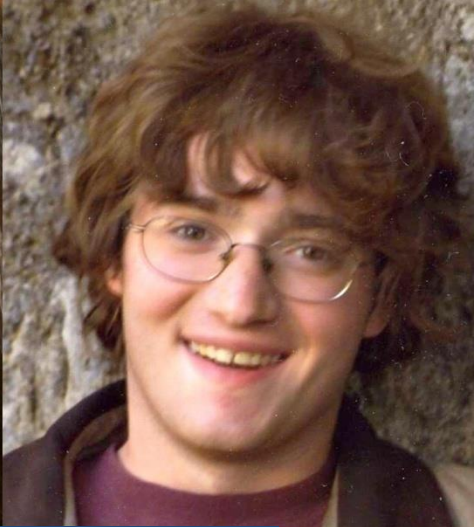


Lumacaftor/Ivacaftor Improved FEV₁

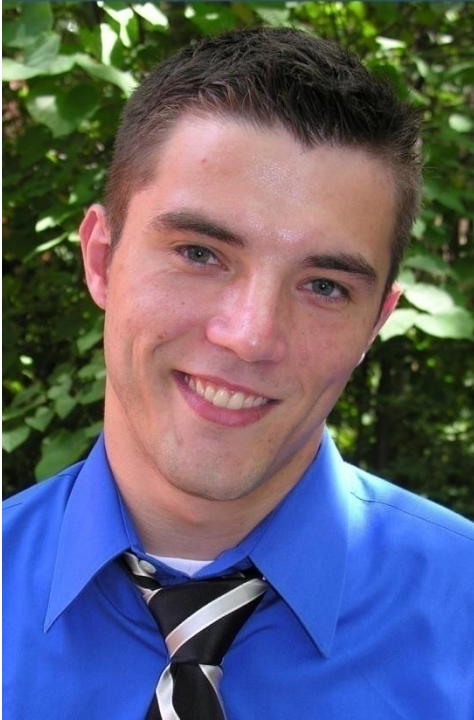


2nd Generation Modulators Restore CFTR Activity





Can we do better?



Corrector Therapy

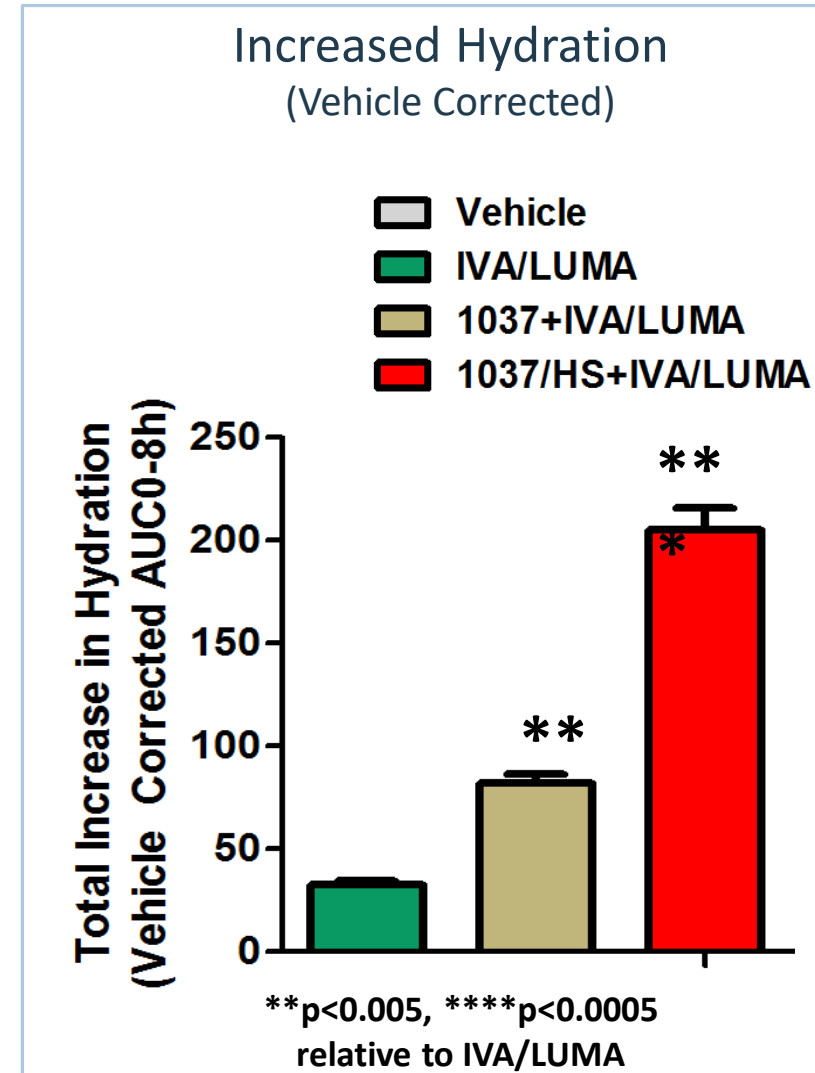
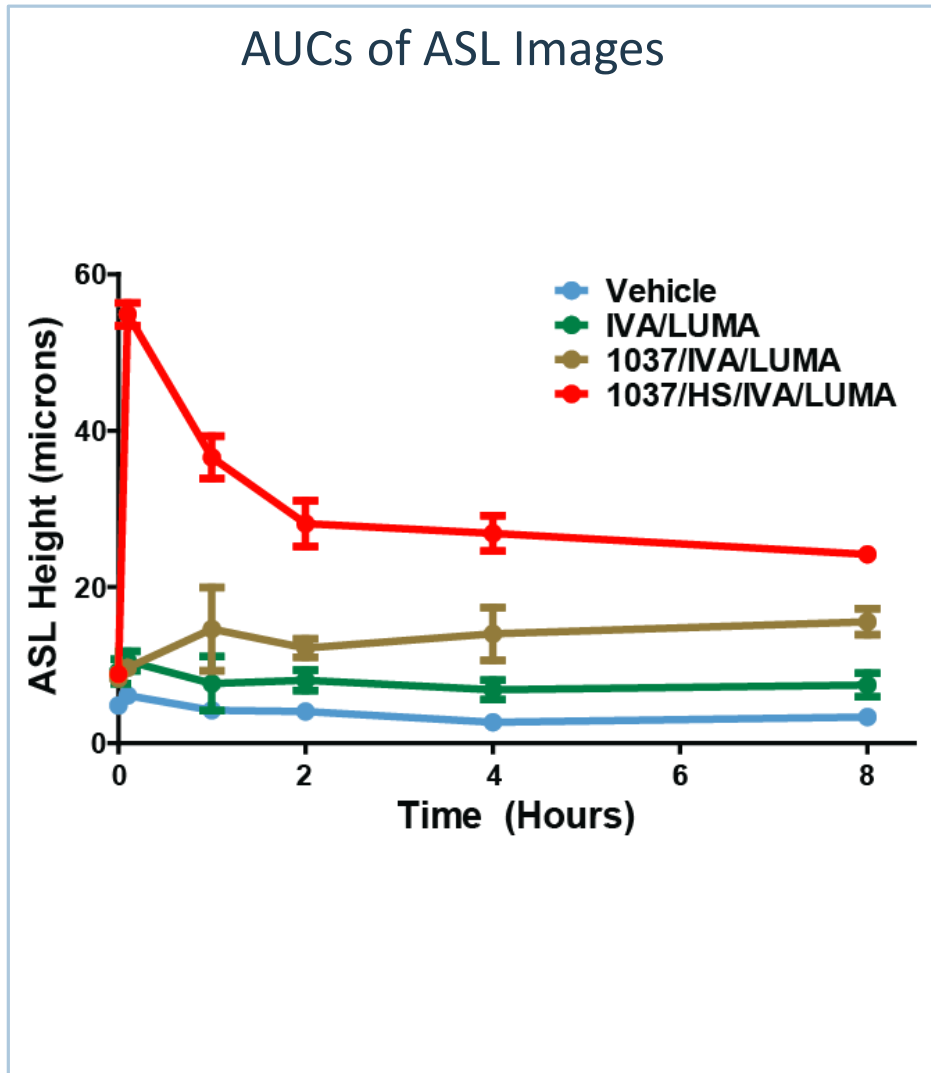
- Two 2nd Generation Correctors now in clinical studies: VX-152 and VX-440
- Each additive or synergistic with first generation correctors in vitro (i.e. VX-661 or VX-809)
- CF trial design in development

Vertex – ENaC blocker Program (with Parion)

- P-1037 / VX-371 Currently enrolling Phase 2a as monotherapy (N=120, 2 week study)
- Combination with corrector/potentiator therapy will follow



Comparison ASL Heights: Iva/Luma +/- P-1037



Source: Parion 2015 NACFC Poster



genzyme
A SANOFI COMPANY



abbvie



PARION
SCIENCES



NOVARTIS



FLATLEY
DISCOVERY LAB
SEEKING A CURE FOR CYSTIC FIBROSIS



REATA
PHARMACEUTICALS



Pfizer



BAYER



N30
PHARMA



VERTEX



PROTEOSTASIS
THERAPEUTICS



Nivalis
THERAPEUTICS



Shire



ProQR



SPYRYX
BIOSCIENCES

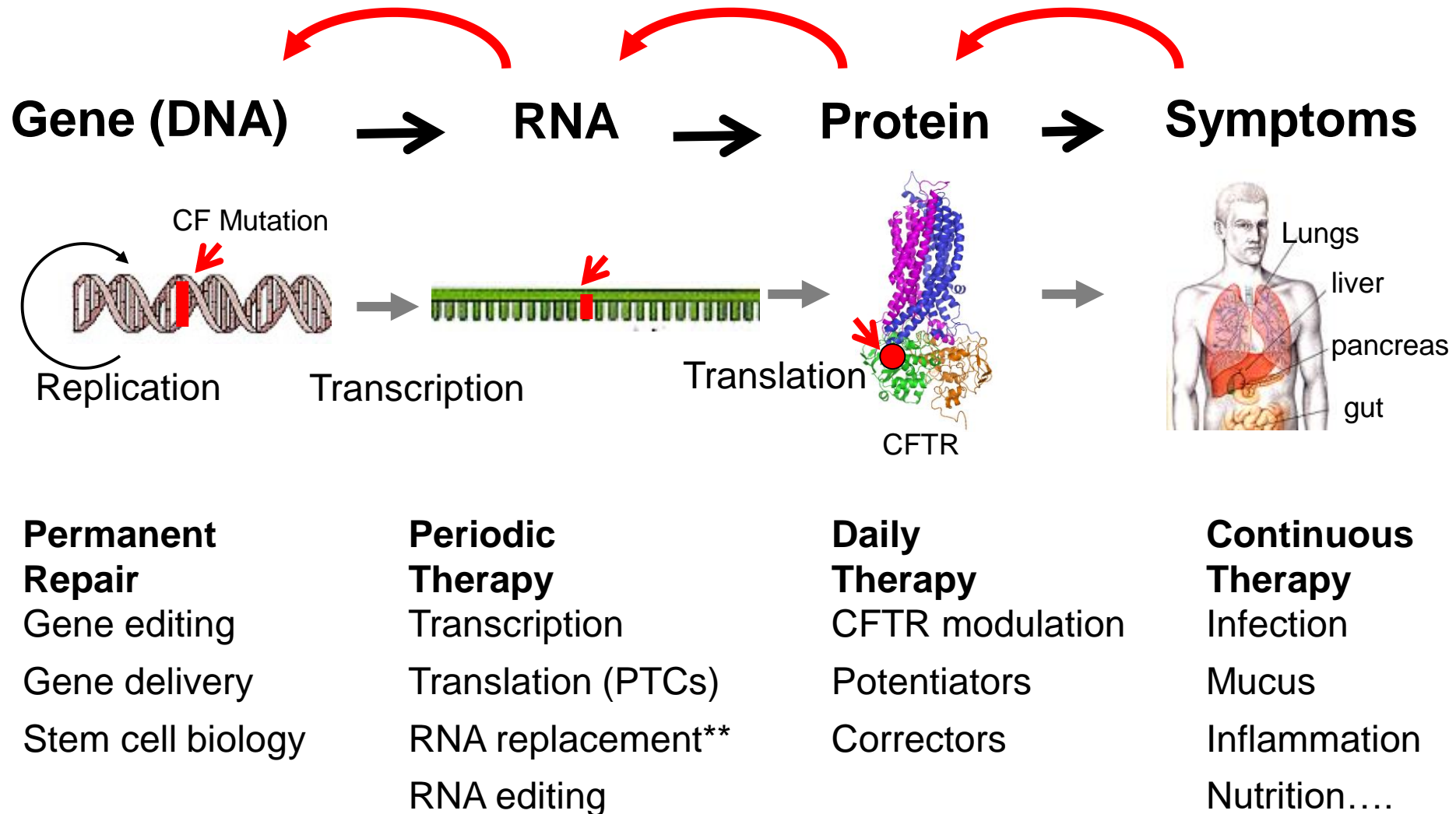
Explosion of CFTR Modulator Trials

1. **PTC** – Ataluren – Phase 3 – Read through stop codons
2. **ProQR** – QR-010- Phase I - RNA repair for F508del
3. **Bayer** – Riociguat – Phase 2 – Corrector
4. **Novartis** – Phase 2 - Potentiator
5. **Nivalis** – N9115 – Phase 2 - Corrector
6. **John Flatley Lab** – Phase 2 – Corrector

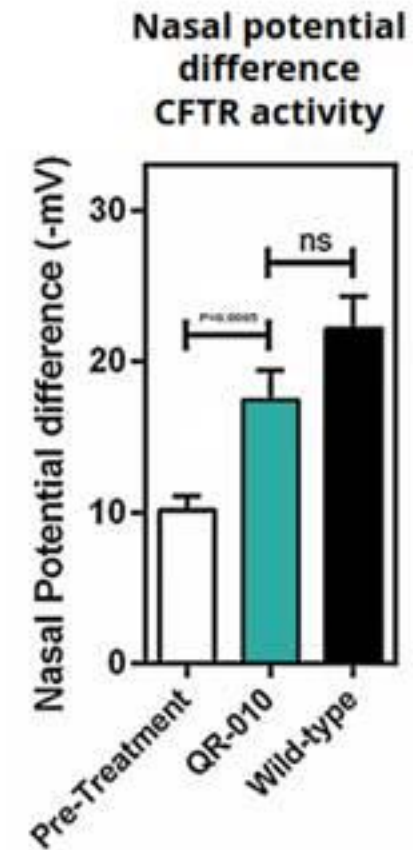
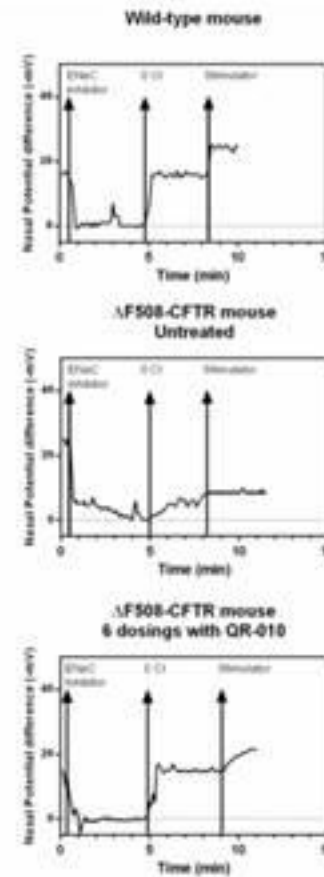
“Second Generation” – mid to late 2016

1. **Vertex** – VX-152 and VX-440 - Phase 2 - Correctors
2. **Galapagos/AbbVie** – GLPG2665 - Phase 1

A Lifelong Cure For All CF Patients



QR-010 normalizes CFTR activity in CF mice



Recruit world class investigators into CF research

Workshops

CFTR Expression (Oct 2014):	increase level of RNA and protein
Gene Editing (Dec 2014):	repair CFTR DNA mutations
Gene Deliver (Dec 2014):	delivery DNA and editing enzymes
Stem Cells (Mar 2015):	identify and “correct” target cells

Successful RFAs

	Applications received	Funded
Gene expression	19	13
Gene Editing	22	10-12
Gene Delivery	23	7-10
Stem cell biology	29	Review Nov 19

Expect to fund ~40-50 laboratories, 2 companies

~ \$7M investment in 2015, increasing 2016-18

Additional discussions on gene delivery: viral & nanoparticle technologies.

2nd Gen CFTR Modulators: (9 projects)

- Vertex, Pfizer, Genzyme, PTI, Reata, Parion

Nonsense (PTC) mutations: (4 projects, 3 ongoing, 1 in development)

- Southern Research Institute/UAB collaboration
- PTC completing Ataluren phase III trial
- Negotiating an additional large Pharma screen
- Novel oligonucleotide approaches

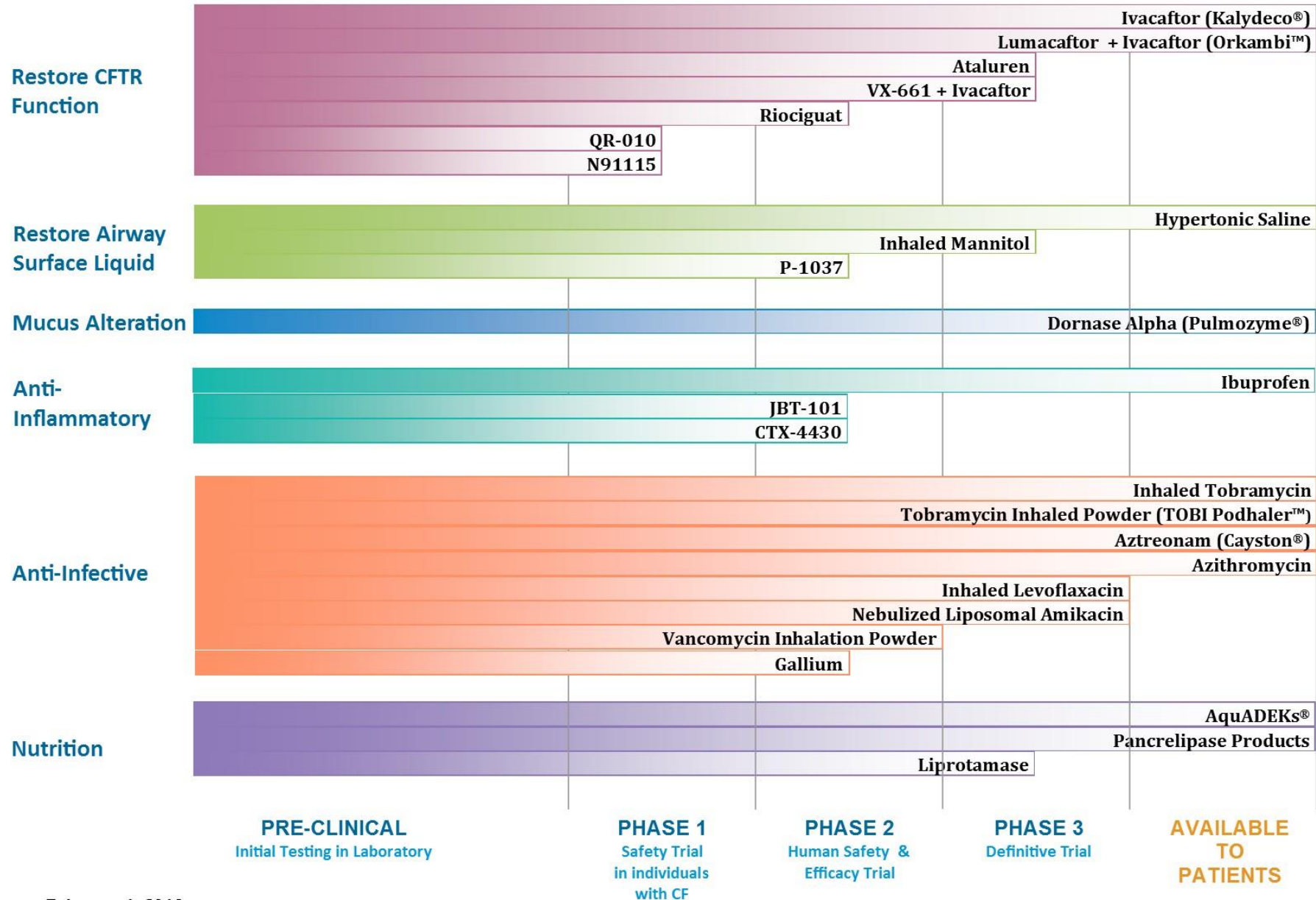
RNA directed therapy: (3 projects, 2 ongoing, 1 in development)

- Shire: direct RNA delivery, ProQR: RNA repair
- Splicing, Expression

Gene editing and delivery: (3 projects; 1 funded, 2 in development)

- CRISPR/Cas9
- Zn Finger nuclease
- novel delivery technologies

Cystic Fibrosis Foundation Therapeutics Pipeline





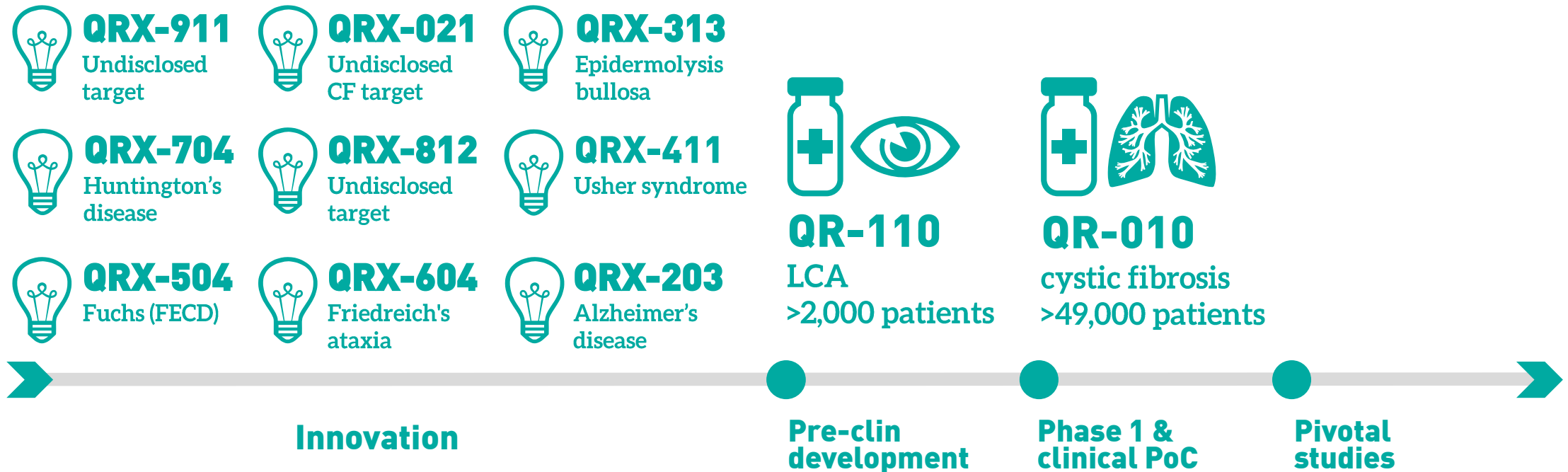
Thank you!



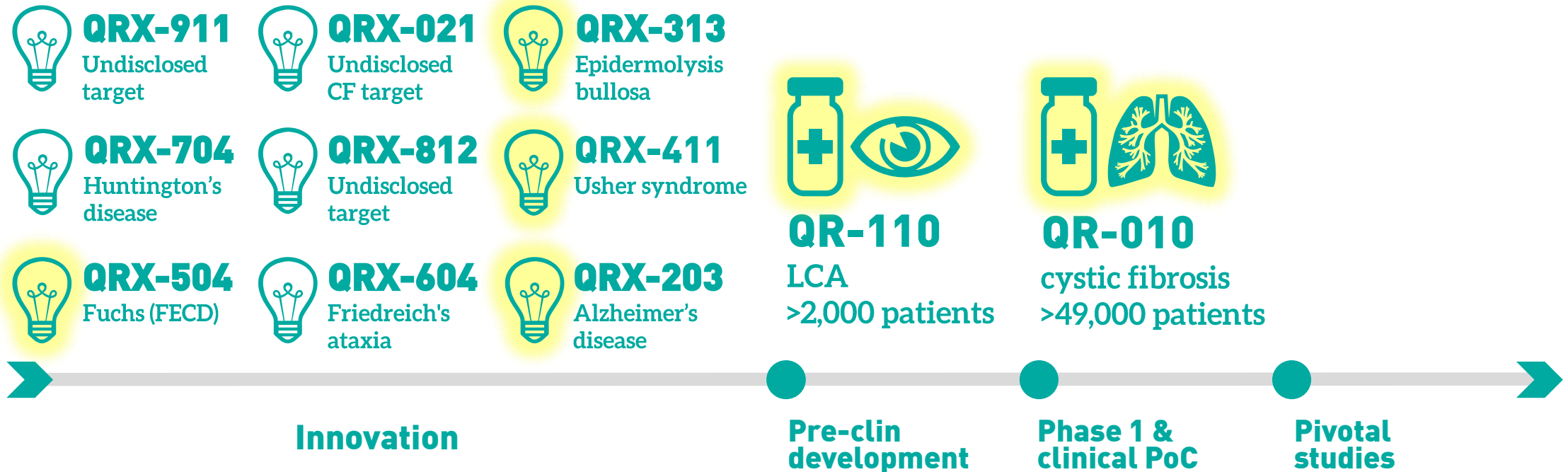
Innovation unit

In-house discovery engine

Research and development pipeline

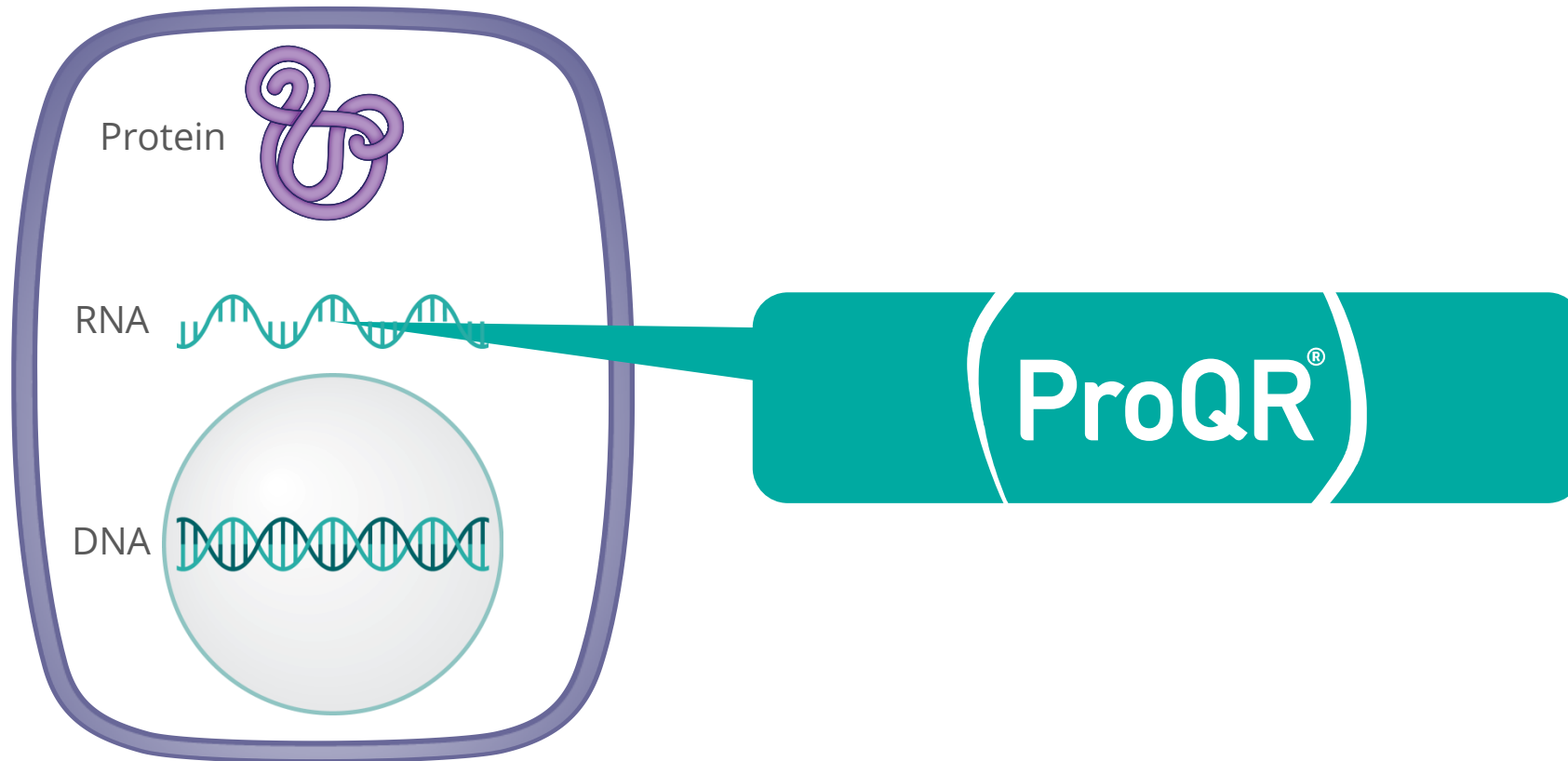


Research and development pipeline

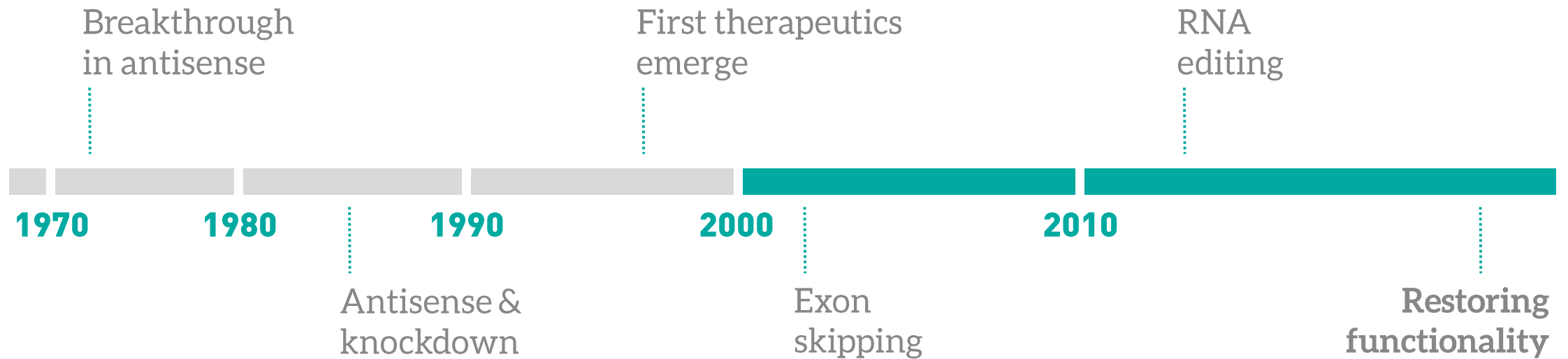


Innovation platform

targeting genetic disorders at the RNA



RNA space



Approach



Well understood causality

Genetic defect leading to disease manifestation well understood



Patient specific

High unmet needs



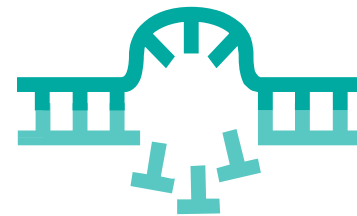
Intellectual property

Aggressive patenting strategy
Broad IP portfolio



Feasible delivery

Feasible delivery route to target organ



Technology based

RNA modulation to restore wild-type functionality

Promising programs in 5 therapeutic areas



CNS

Huntington's disease
Alzheimer's disease



Ophthalmology

LCA10
Usher syndrome
Fuchs (FECD)



Respiratory

Cystic fibrosis



Dermatology

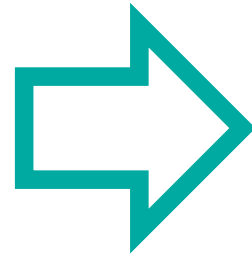
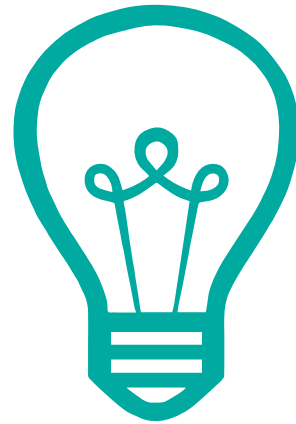
Dystrophic EB



Neuromuscular

Friedreich's ataxia

Selecting the best programs



**Well understood
causality**



Unmet need



IP position



**Strong
proof-of-concept**



Feasible delivery



QR-110

Splice correction for p.Cys998X causing Leber's congenital amaurosis (LCA10)

Leber's congenital amaurosis disease background

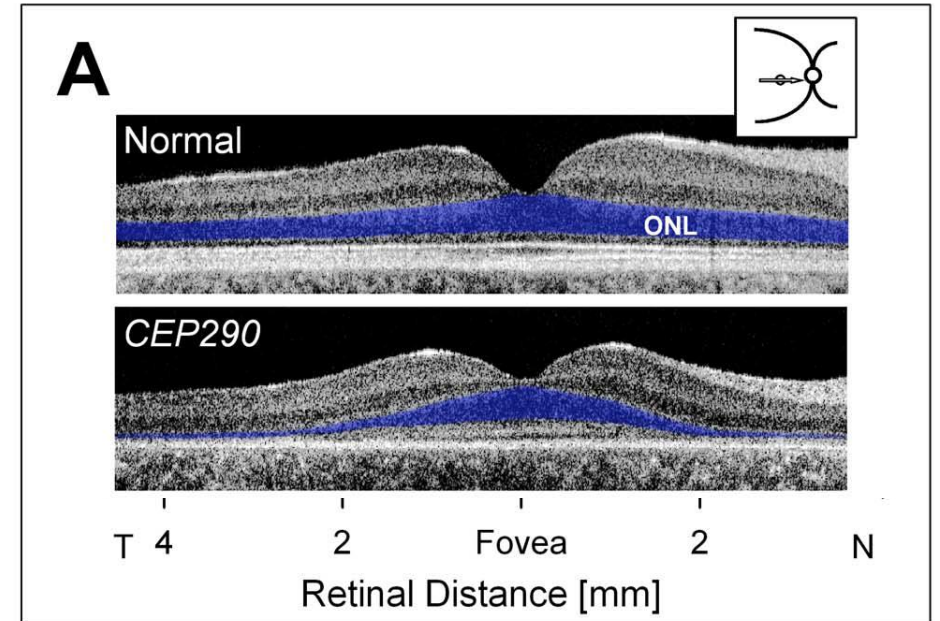
- LCA is a broad set of diseases
 - 18 types
 - Caused by many mutations
- Different phenotypes
 - LCA2: RPE65
 - LCA10: CEP290 (a ciliopathy)
- **LCA10** - p.Cys998X: ~2,000 LCA patients in the Western world
- No treatments available

LCA10 Clinical Phenotype

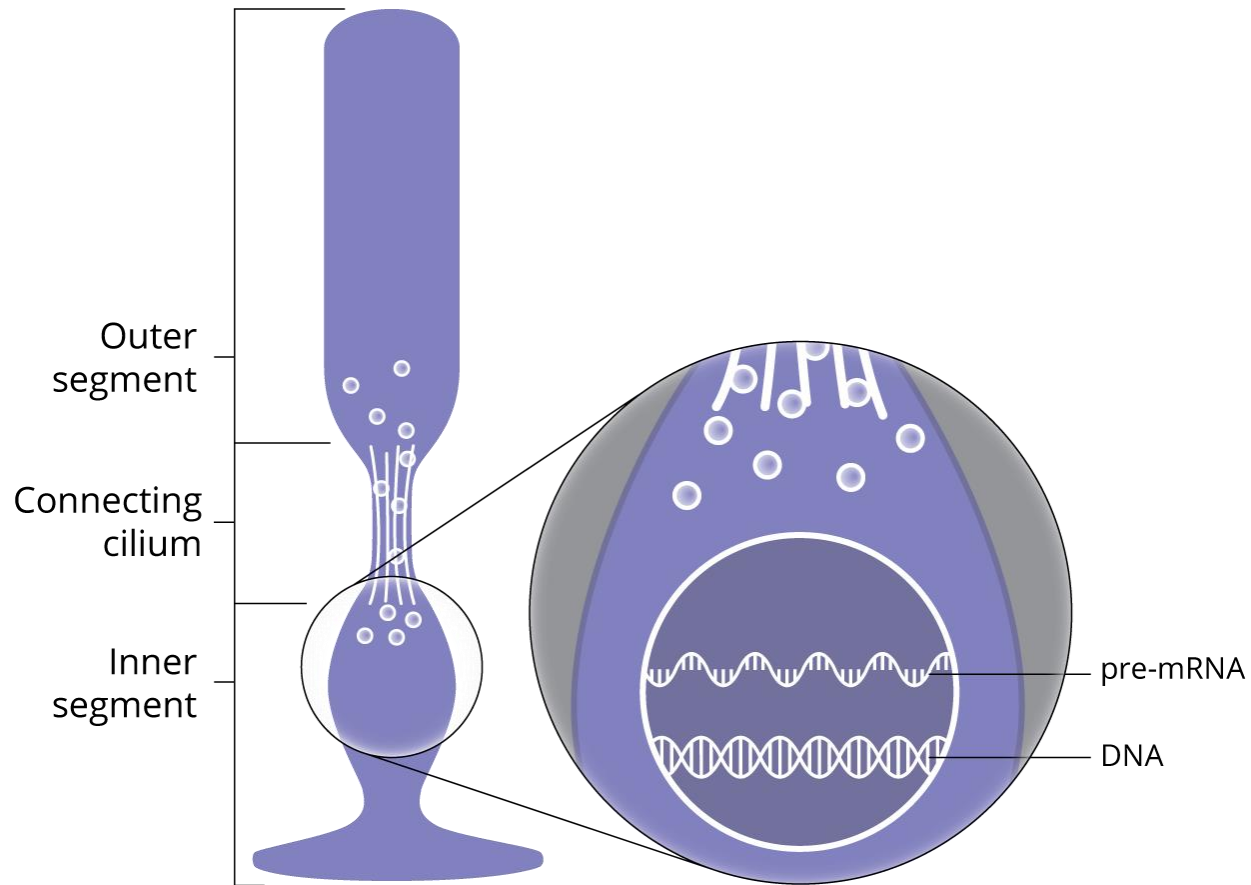
- Most severe form of early childhood blindness
- Very early severe vision loss with onset in the first months of life
- Symptoms include sensory nystagmus (involuntary eye movement), amaurotic pupils, oculo-digital signs, and absent electrical signals on electroretinogram (ERG).
- Is associated with a cone-sparing macular presentation

LCA10 Clinical Phenotype

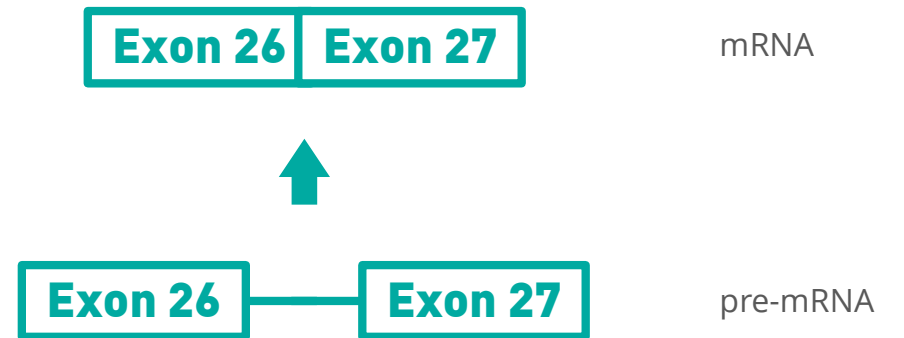
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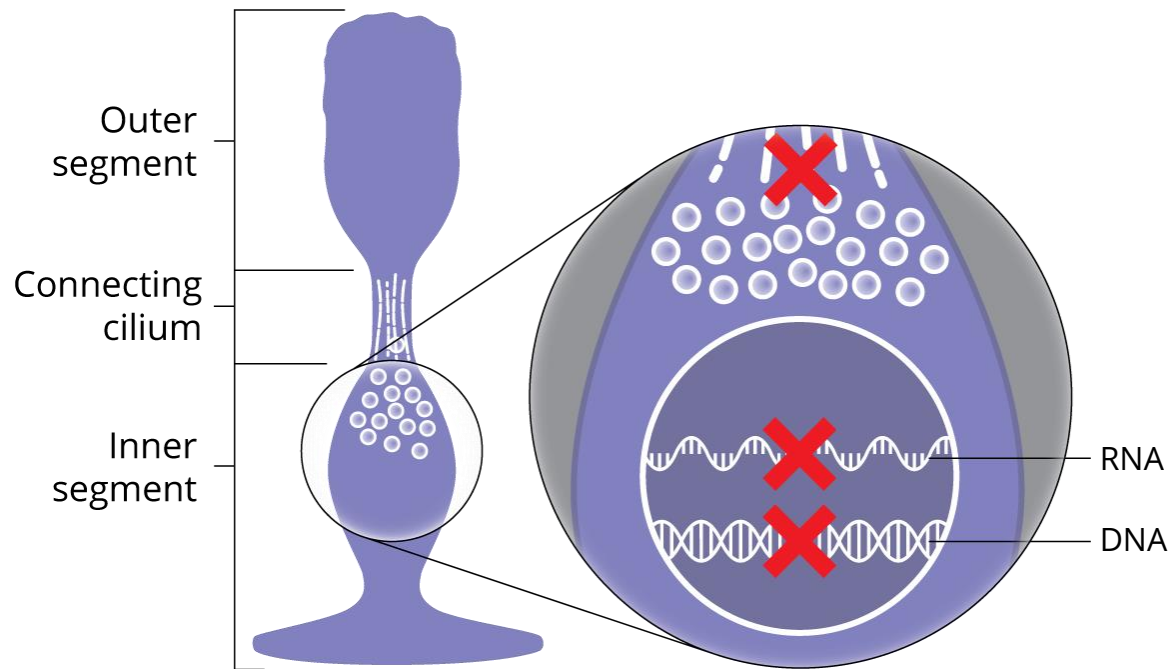
QR-110 for LCA10



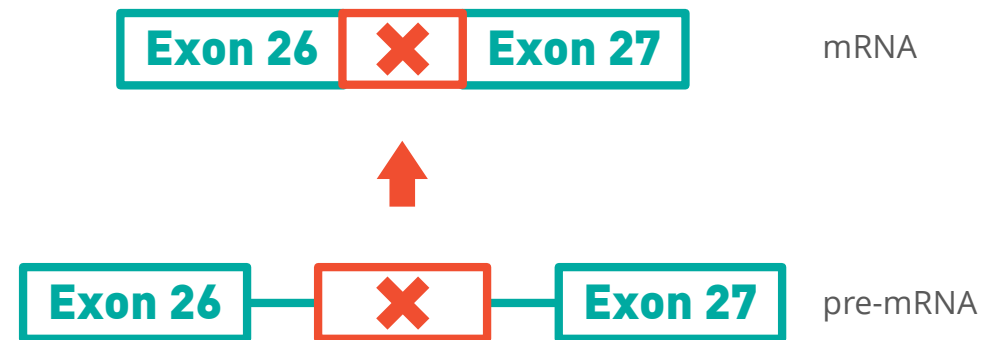
In wild-type cells
CEP290 maintains cilium
structure and enables
normal protein transport



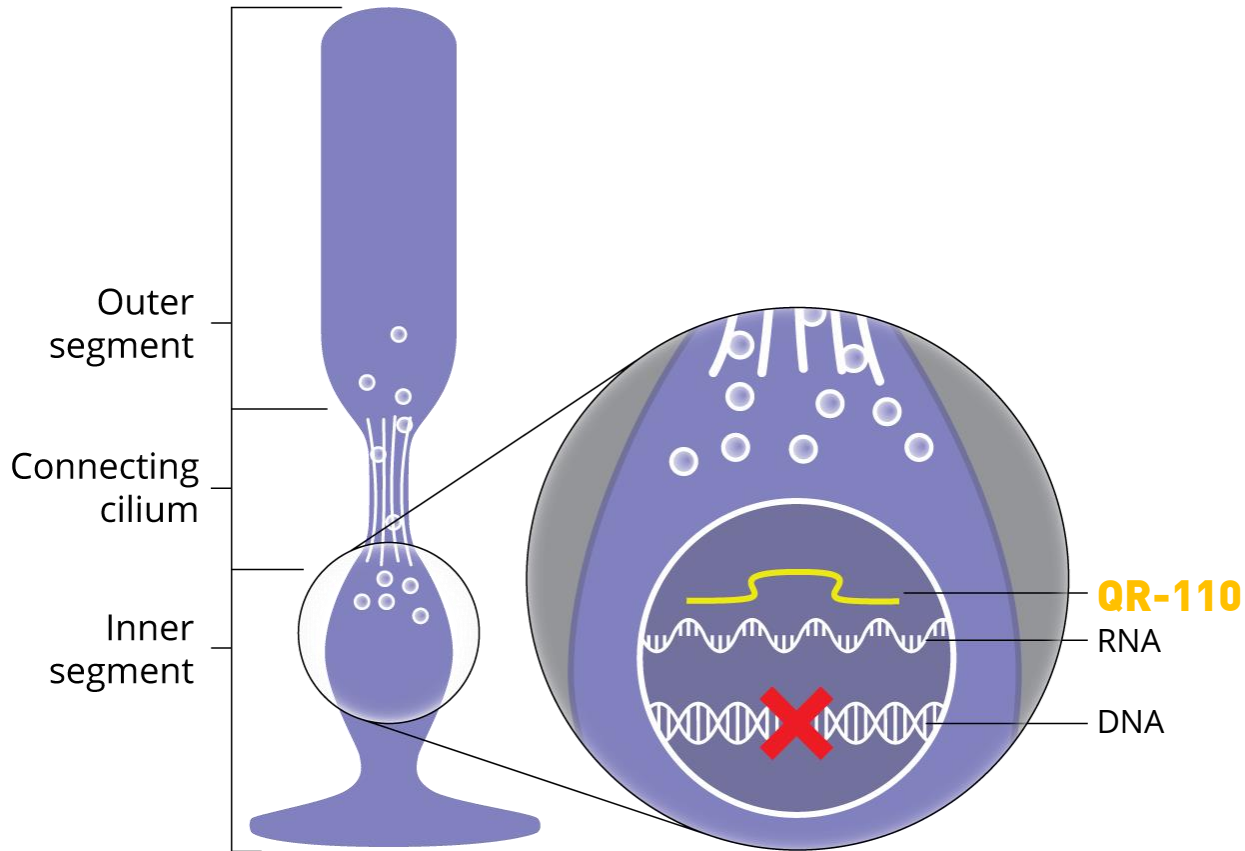
QR-110 for LCA10



In p.Cys998X-LCA10 cells protein transport is hampered and the outer segment degenerates



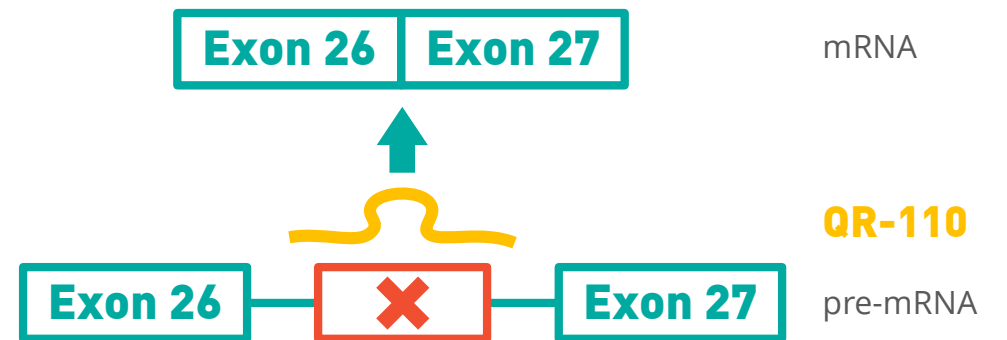
QR-110 for LCA10



Molecular Therapy- Nucleic Acids

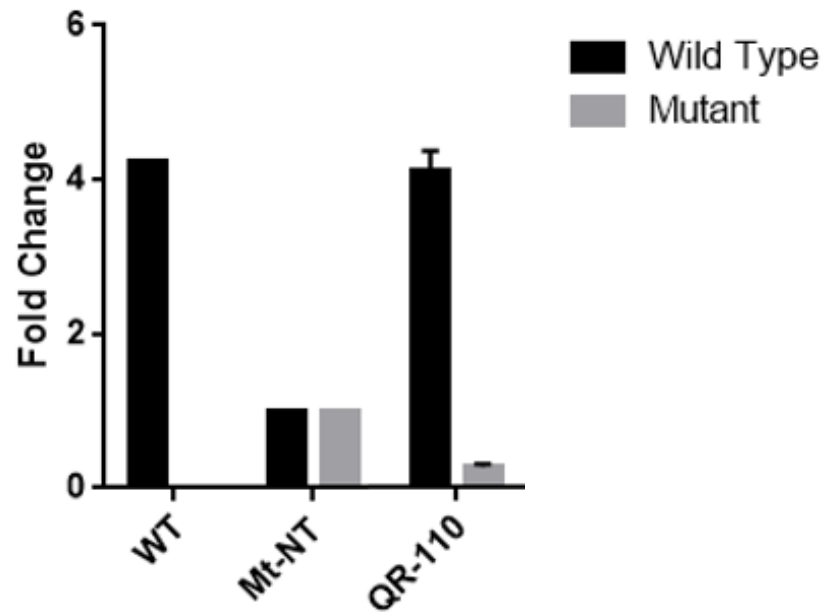
Antisense Oligonucleotide (AON)-based Therapy for Leber Congenital Amaurosis Caused by a Frequent Mutation in *CEP290*

Rob WJ Collin^{1,4}, Anneke I den Hollander^{1,4}, Saskia D van der Velde-Visser¹, Jeannette Bennicelli⁵, Jean Bennett⁶ and Frans PM Cremers^{1,3}

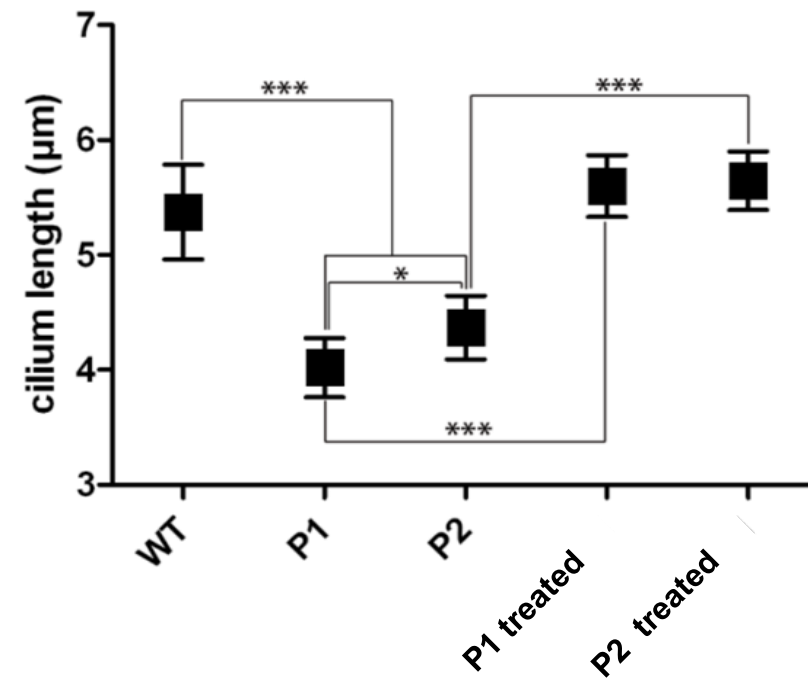


Restoration of mRNA and functionality in patient fibroblasts

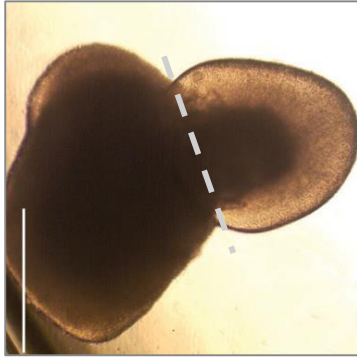
mRNA profile restoration
(patient fibroblasts)



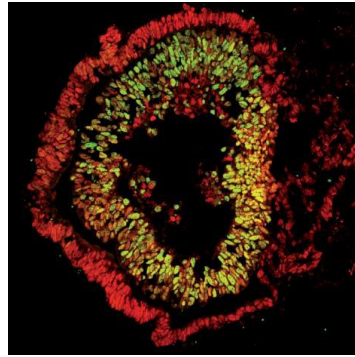
Functional restoration
(patient fibroblasts)



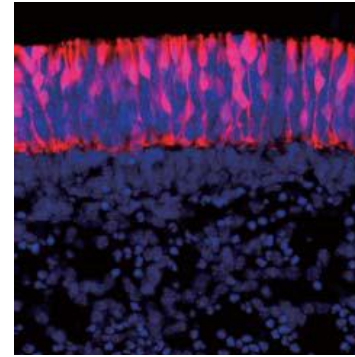
Restoration of mRNA in eye-cups



Eye cup model of iPSC



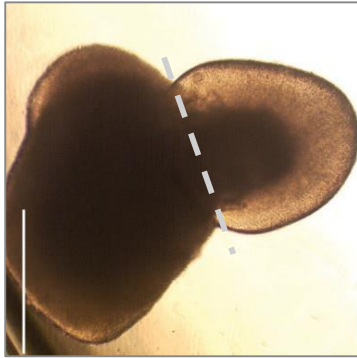
emerging eye cup
with retinal pigment
epithelium in red



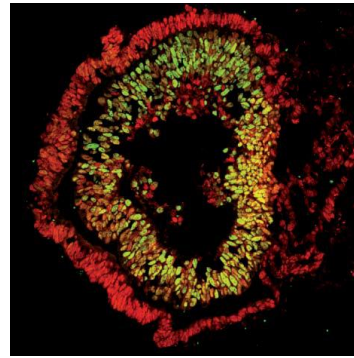
Red = rhodopsin
pigment only in photoreceptors
which sense light.

Zhong et al., 2014

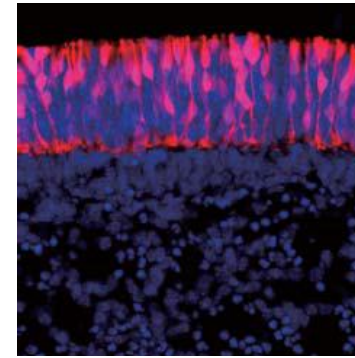
Restoration of mRNA in eye-cups



Eye cup model of iPSC



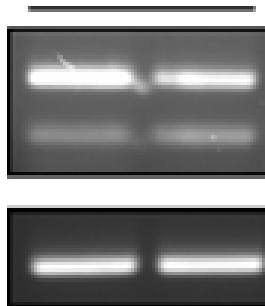
emerging eye cup
with retinal pigment
epithelium in red



Red = rhodopsin
pigment only in photoreceptors
which sense light.

Zhong et al., 2014

Control

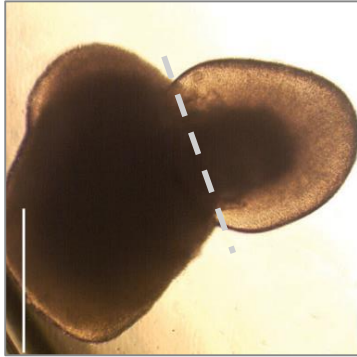


Mutant
Wild-type

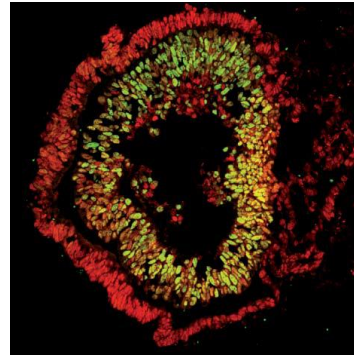


GAPDH

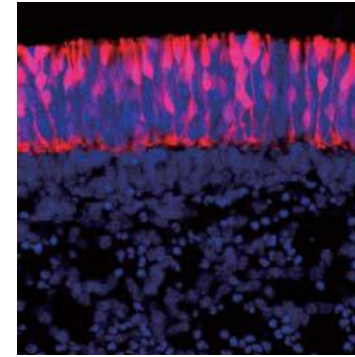
Restoration of mRNA in eye-cups



Eye cup model of iPSC

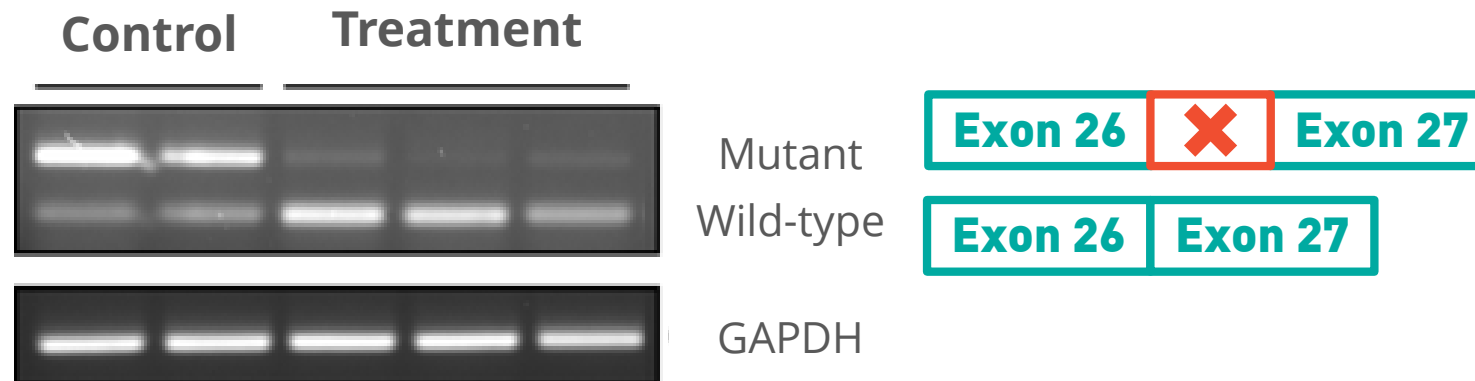


emerging eye cup
with retinal pigment
epithelium in red



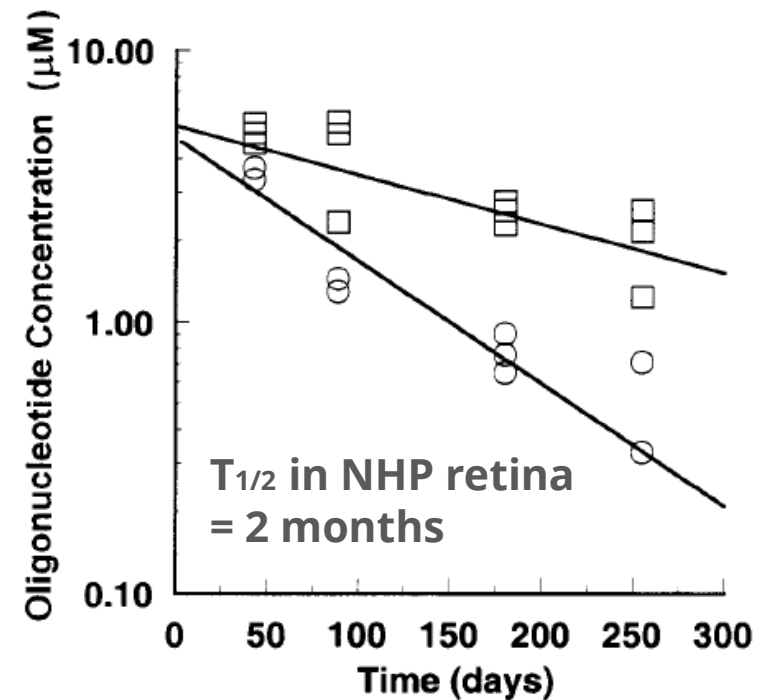
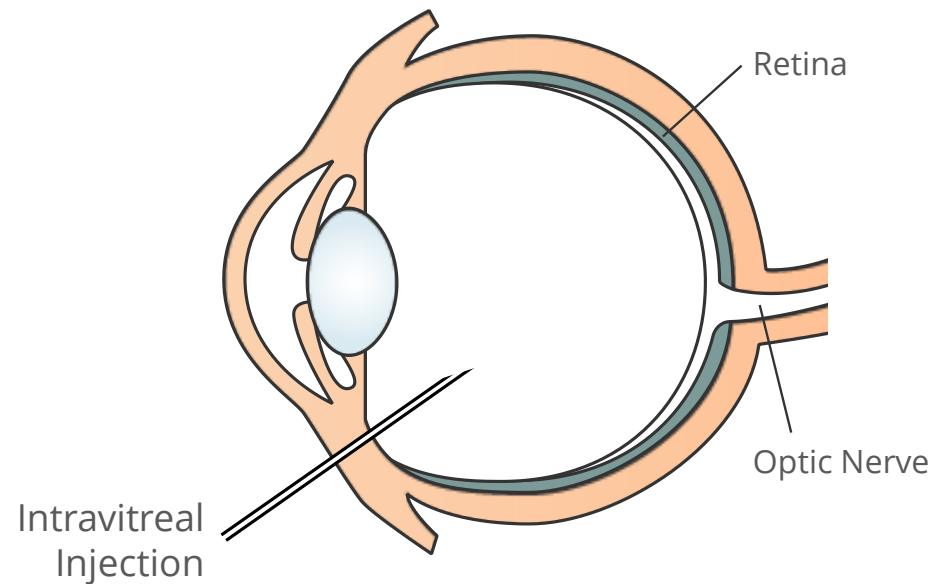
Red = rhodopsin
pigment only in photoreceptors
which sense light.

Zhong et al., 2014



Intravitreal delivery

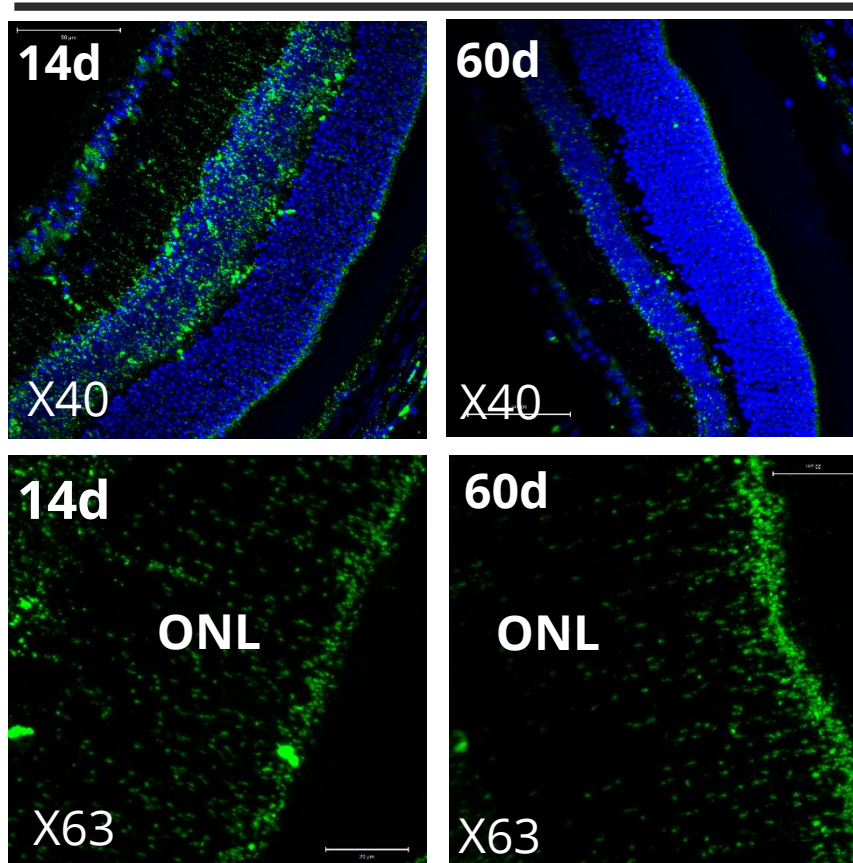
- Eye well validated target for oligo's
- Routine procedure (IVT)
- Infrequent dosing expected
- Long retinal half-lives
- A number of marketed therapeutics including intravitreal oligonucleotides



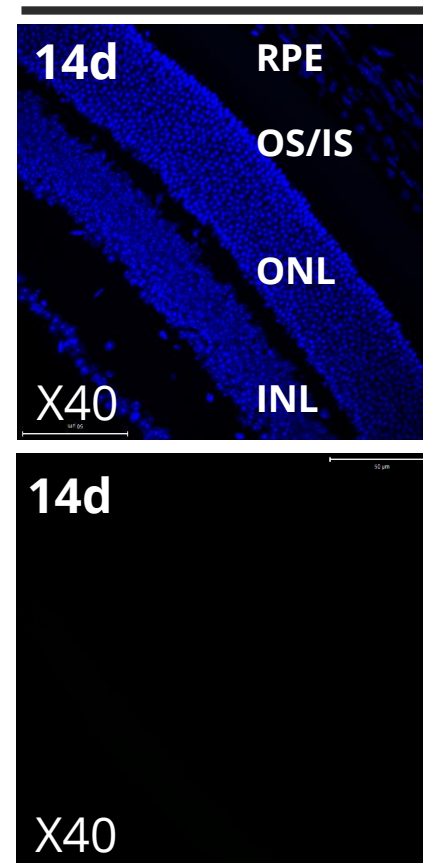
Henry et al., 2001
IOVS 42 2646

Efficient delivery to retinal Outer Nuclear Layer

100ug 6FAM-QR-110 IVT 14d and 60d mouse



6FAM only 14d mouse



6FAM-QR-110 (green)
or FAM only (green)

DAPI (blue)

100ug in mouse well
tolerated for 60 days

QR-110 for Leber's congenital amaurosis

Clinical program to start in 2016

Preliminary study outline:

- Phase 1b (no placebo/sham injection)
- 8+ patients with residual ONL (observable retinal structure)
- Repeated doses in one eye (intravitreal injection)

Primary endpoints

- Safety
- Tolerability

Secondary endpoints

- Electroretinogram (ERG)
- Full-field stimulus test (FST)
- OCT (retinal degradation area)
- Visual acuity
- Patient reported outcome
- Mobility testing



QRX-411

Splice correction for Usher's syndrome

QRX-411 for Usher's syndrome

Leading genetic cause of deafness & blindness

- Usher type II
- Retinitis pigmentosa
 - onset: childhood
 - (almost) complete blindness in the 3rd or 4th decade of life
- Congenital hearing impairment

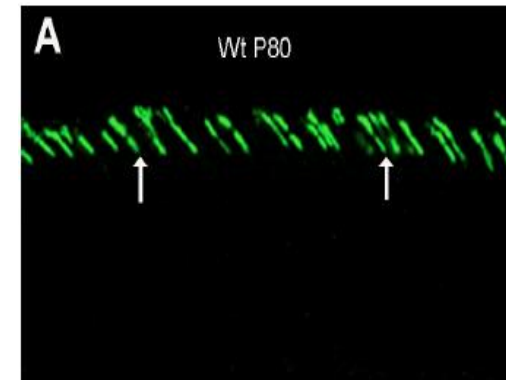
Most common mutations in *USH2A* gene

- *USH2A* required for transport across the connecting cilium
- Lack of *USH2A* leads to slow degeneration of the photoreceptors
- AON treatment for PE40 mutation, potential to expand to other mutations.

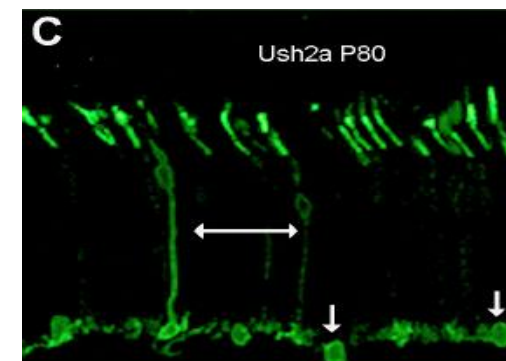
High unmet need

- >15,000 *USH2A* patients in western world

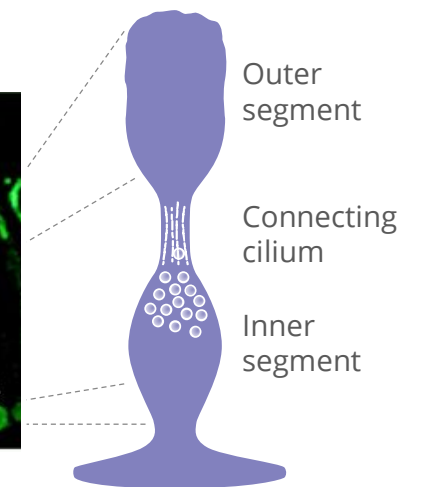
Opsin protein in WT mouse



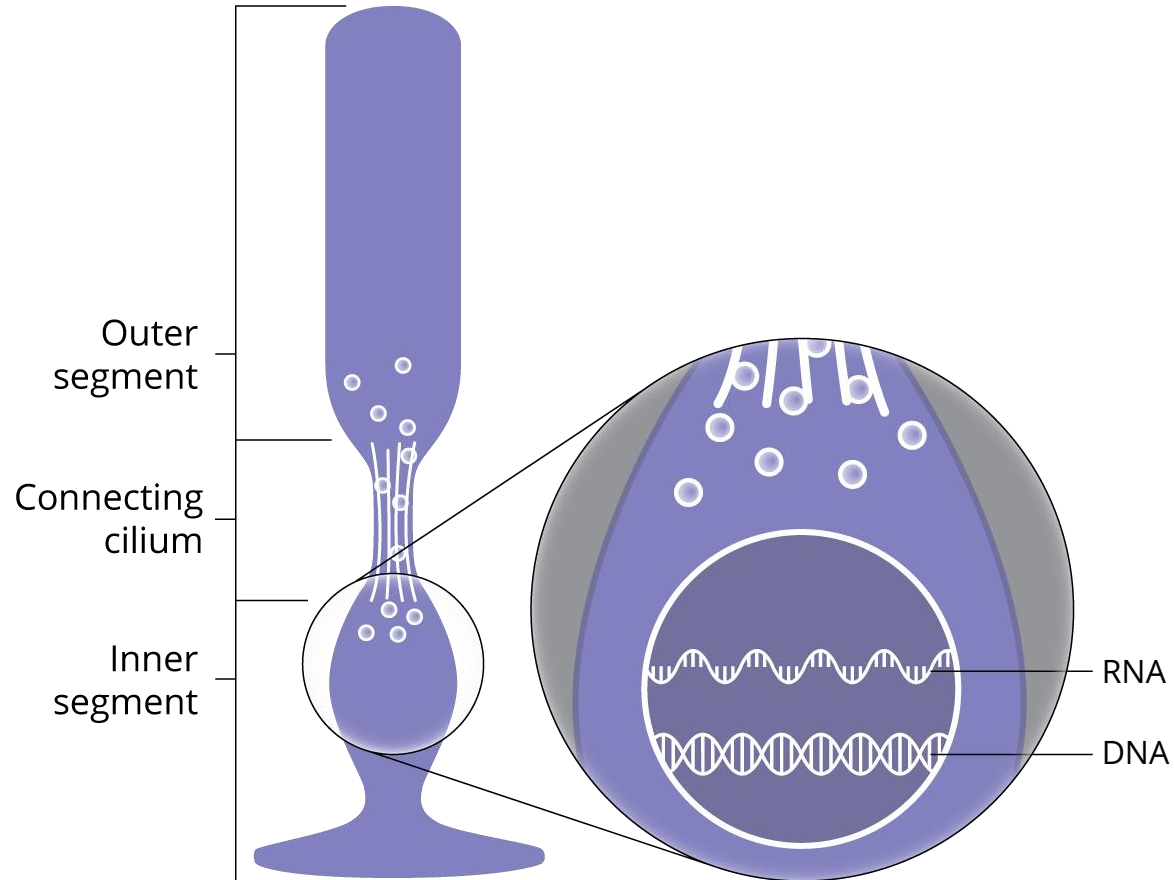
Opsin protein in *USH2A* mutant mouse



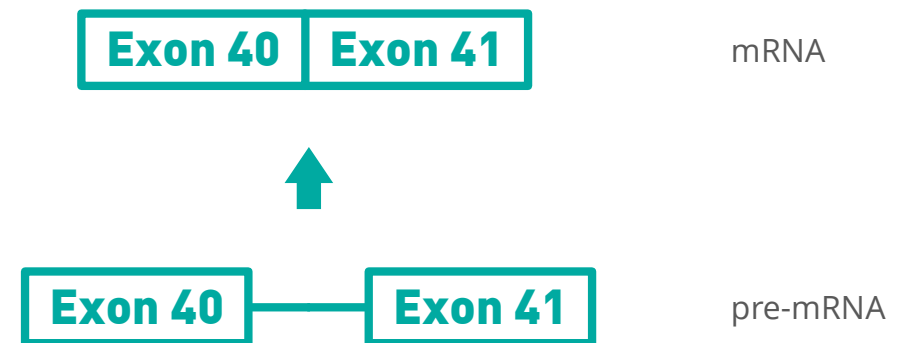
Lu et al., 2010



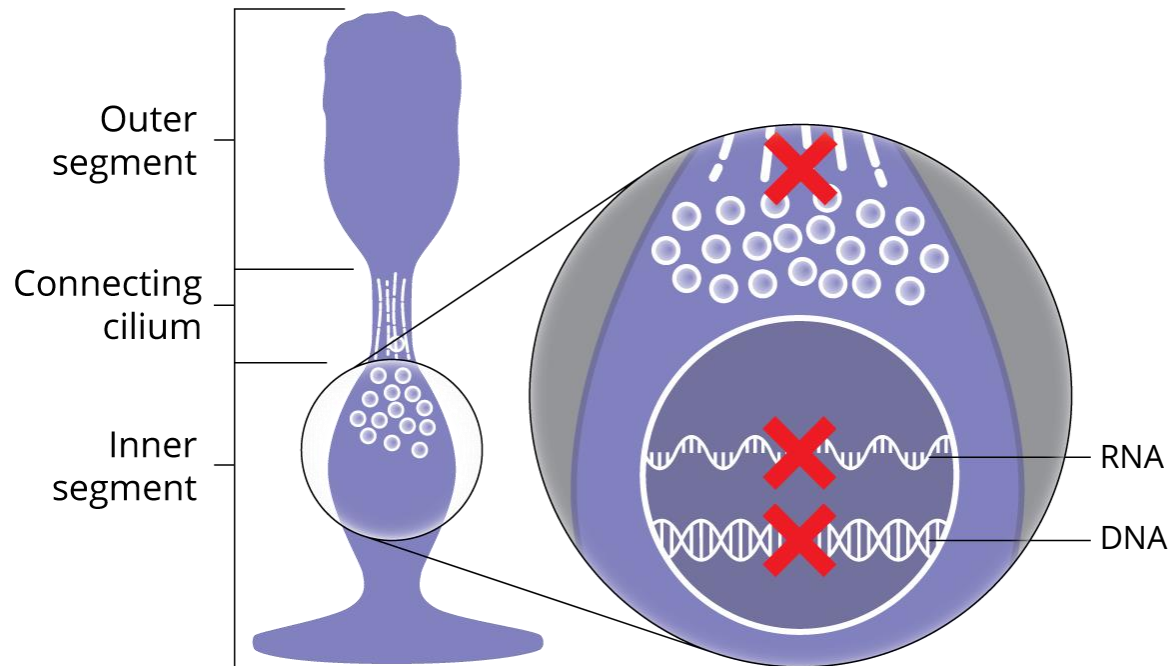
QRX-411 for Usher's syndrome



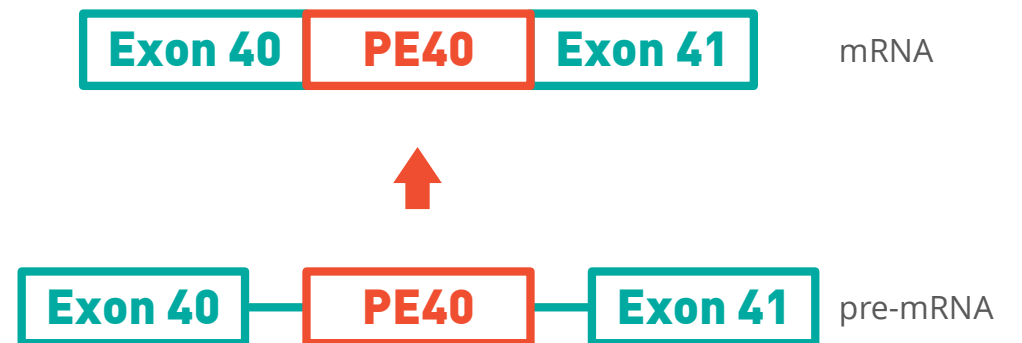
In wild-type cells
Ush2a protein enables
protein transport through
the connecting cilium



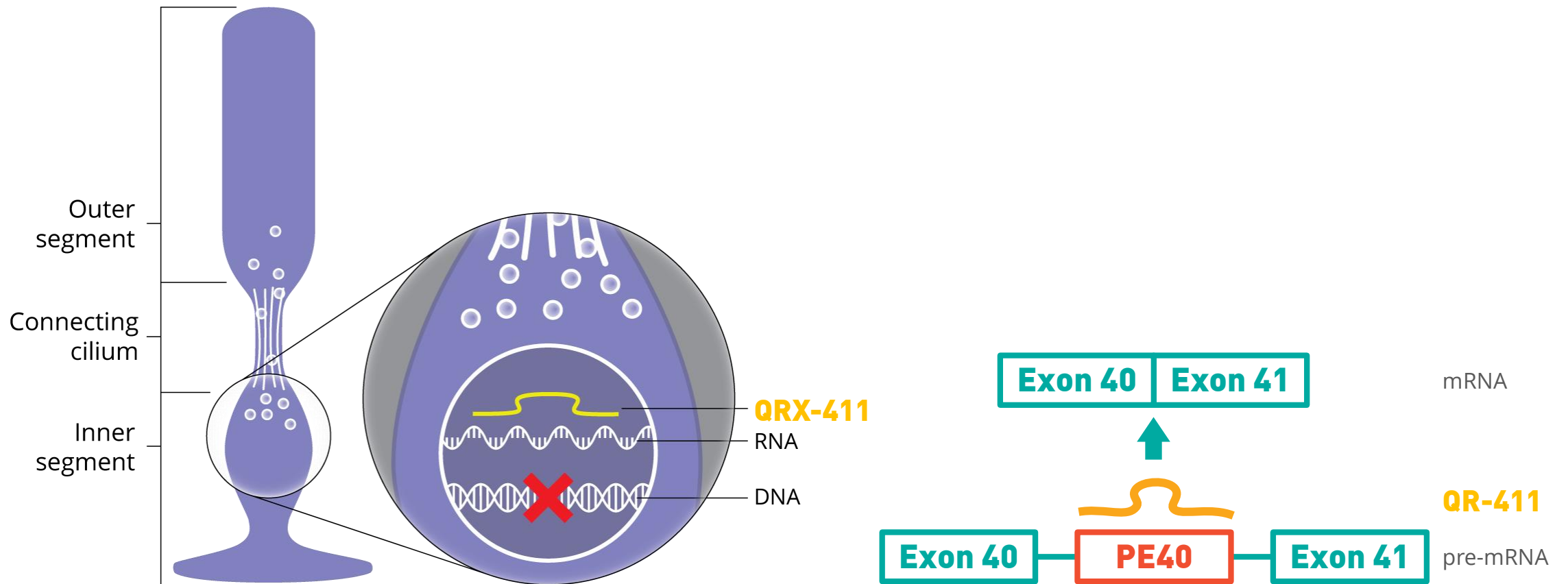
QRX-411 for Usher's syndrome



In cells with the mutation Ush2a protein is not active hampering protein transport over the cilium

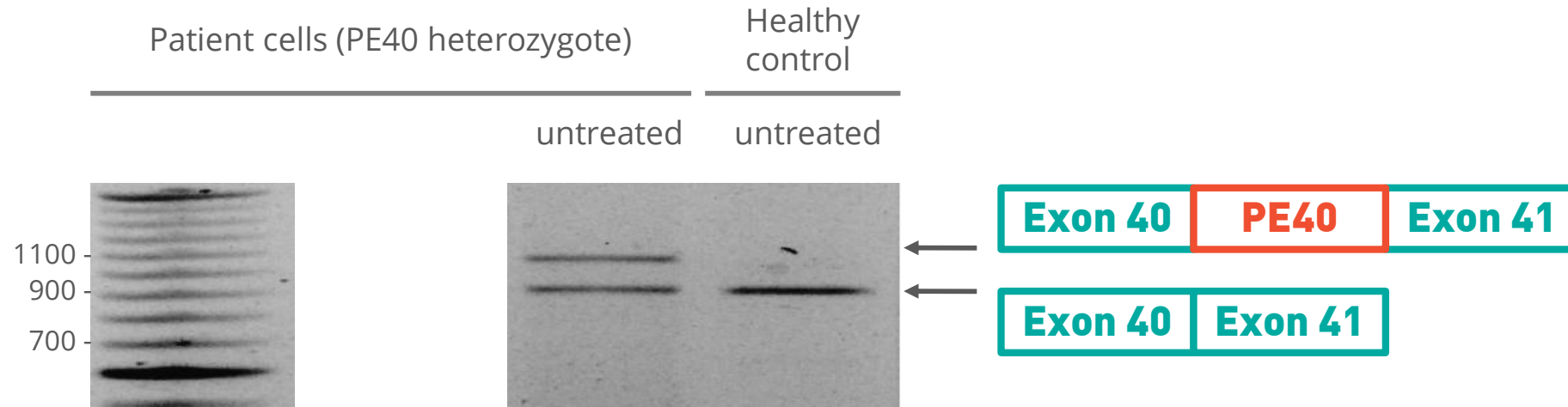


QRX-411 for Usher's syndrome



Strong proof of concept

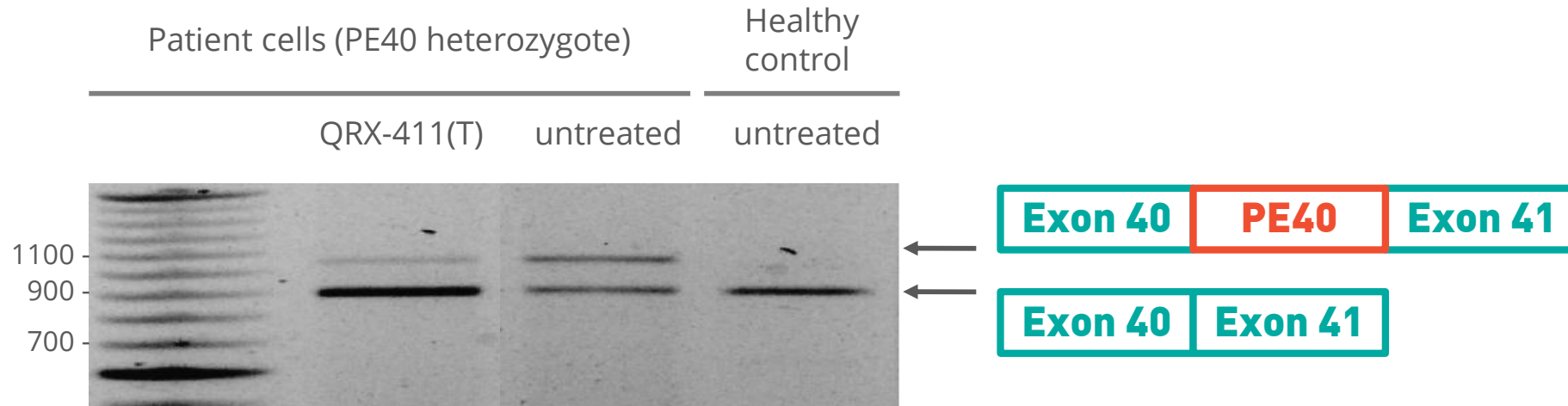
RNA restoration after AON treatment



Radboud University

Strong proof of concept

RNA restoration after AON treatment



Radboud University

QRX-411 status and overview

- ✓ Single stranded oligo nucleotide resulting in WT mRNA
- ✓ Delivery through intravitreal administration
- ✓ Two lead compounds selected



QRX-504

RNA modulation for Fuchs endothelial corneal dystrophy (FECD)

QRX-504 for Fuchs Endothelial Corneal Dystrophy

Progressive degeneration of the cornea

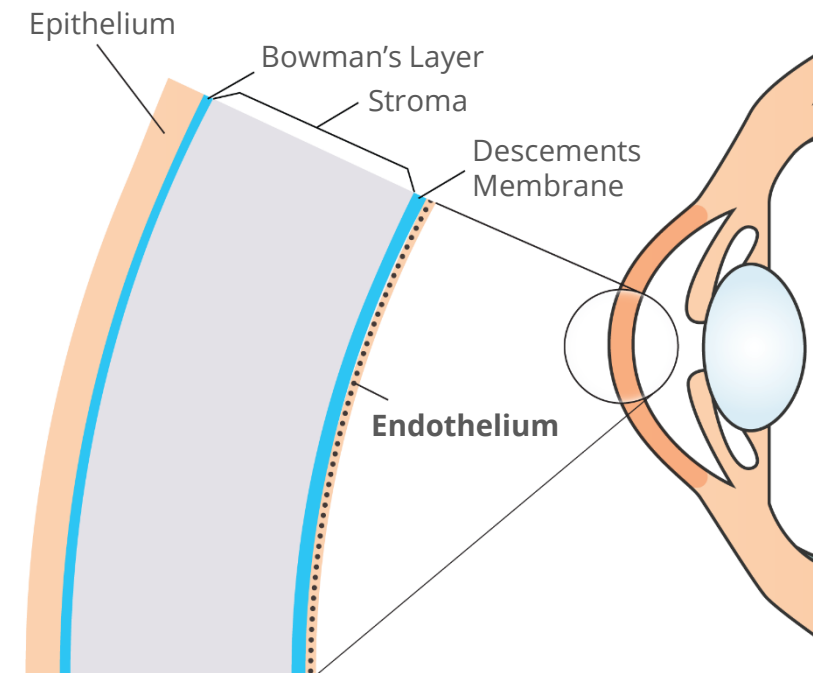
- Reduced or loss of vision due to loss of function of corneal endothelial cells or loss of corneal endothelial cells
- ~5% of middle-aged Caucasians have guttae, a hallmark of FECD. A subset of that group develops a severe phenotype
- Disease is also associated with painful corneal blisters

FECD3 caused by mutations in TCF4 gene

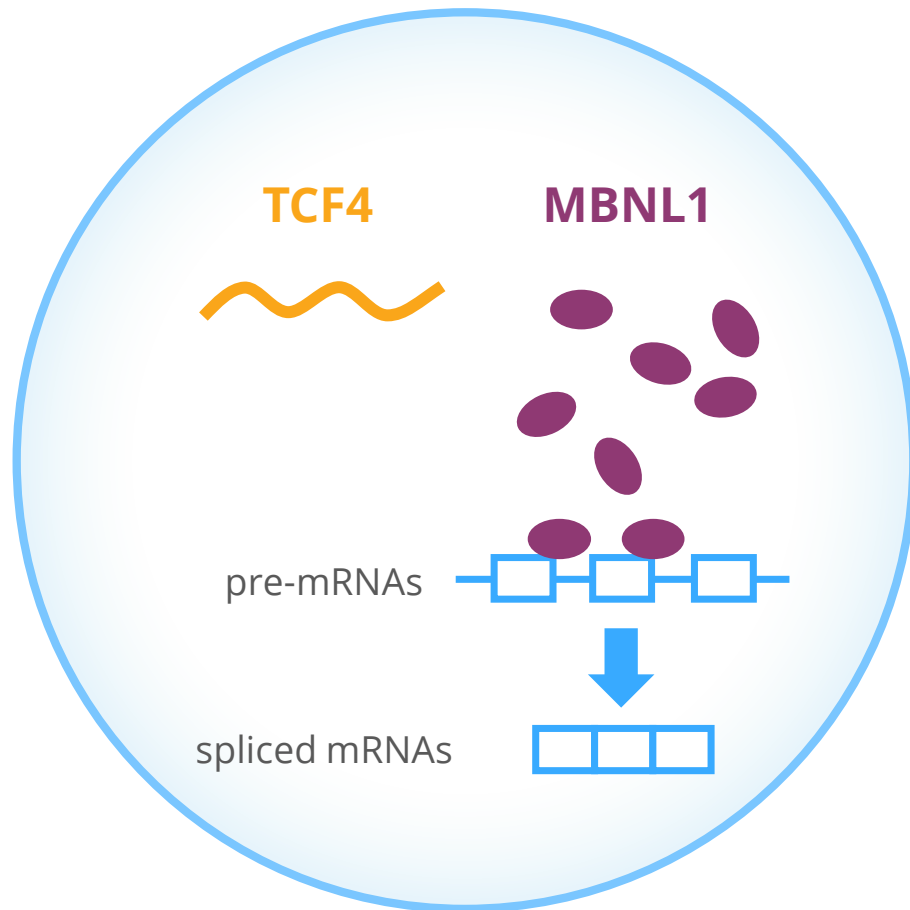
- 75% of population with guttae have TCF4 expansions
- Formation of nuclear RNA foci that sequester splicing factors
- Foci lead to loss of function of endothelium cells

Unmet Need

- Eye disorder, leading to blindness, 15,000 corneal transplants performed annually in the US due to Fuchs
- High unmet medical need

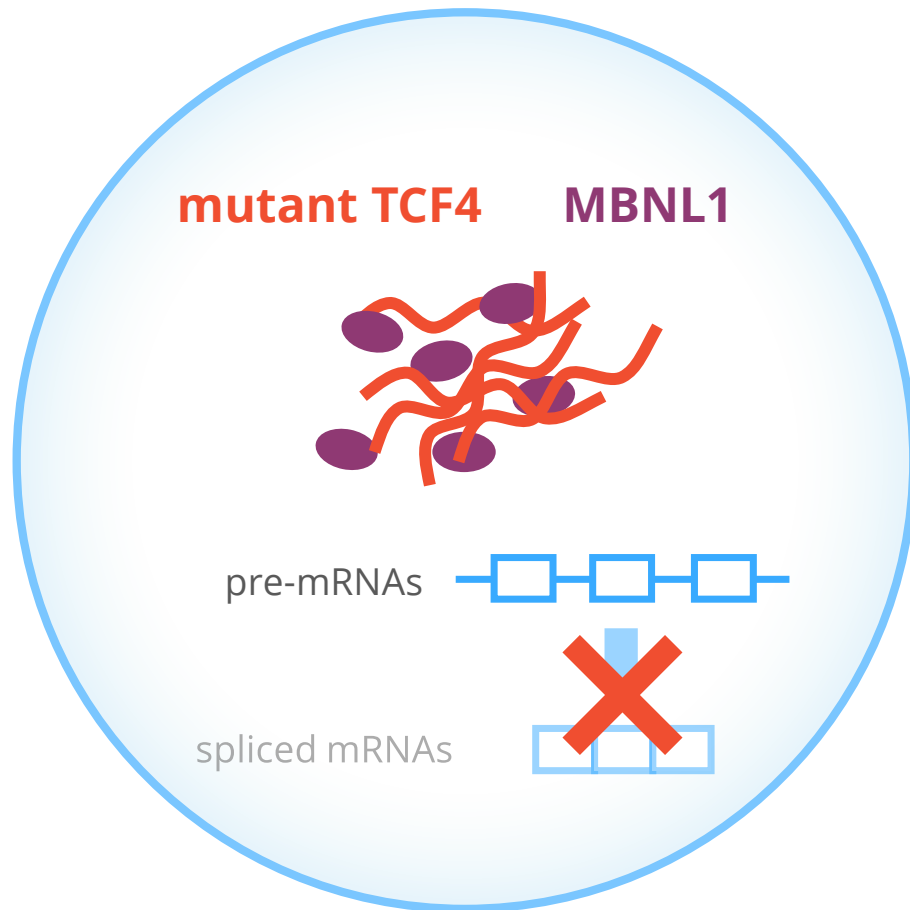


QRX-504 for FECD3



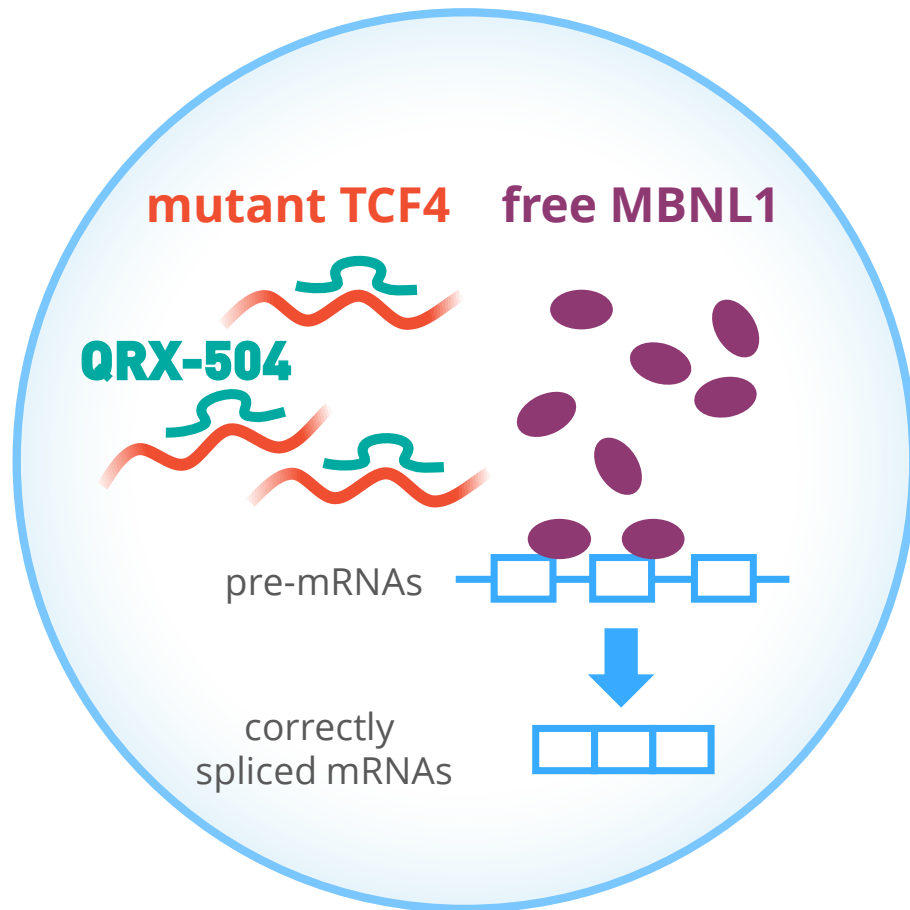
In wild-type cells,
MBNL1 protein
regulates splicing of
many RNAs

QRX-504 for FECD3



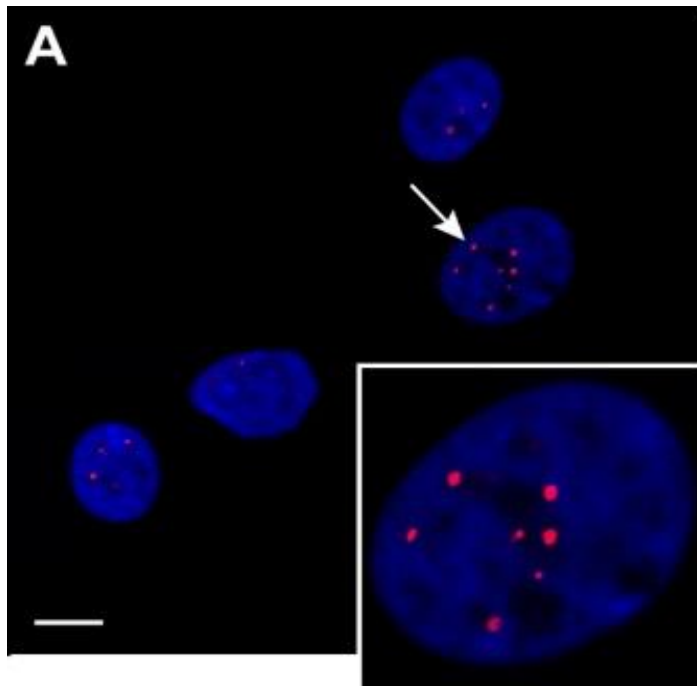
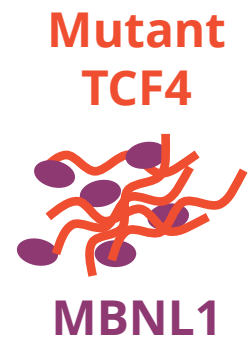
Mutated *TCF4* RNA and MBNL1 form aggregates (foci), and splicing is disrupted

QRX-504 for FECD3

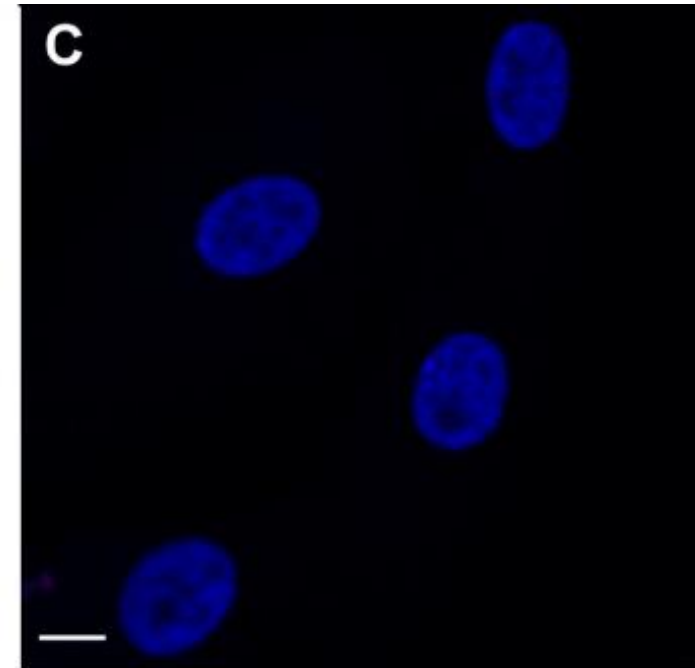


Fuchs patients with mutations in TCF4 have RNA foci

FECD3 is an RNA toxicity disease



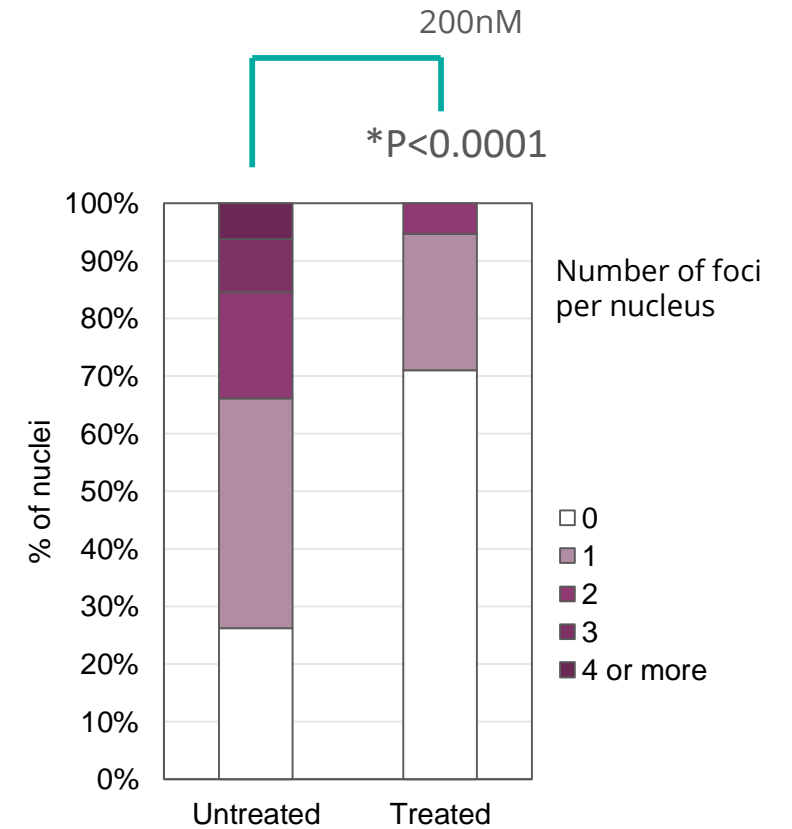
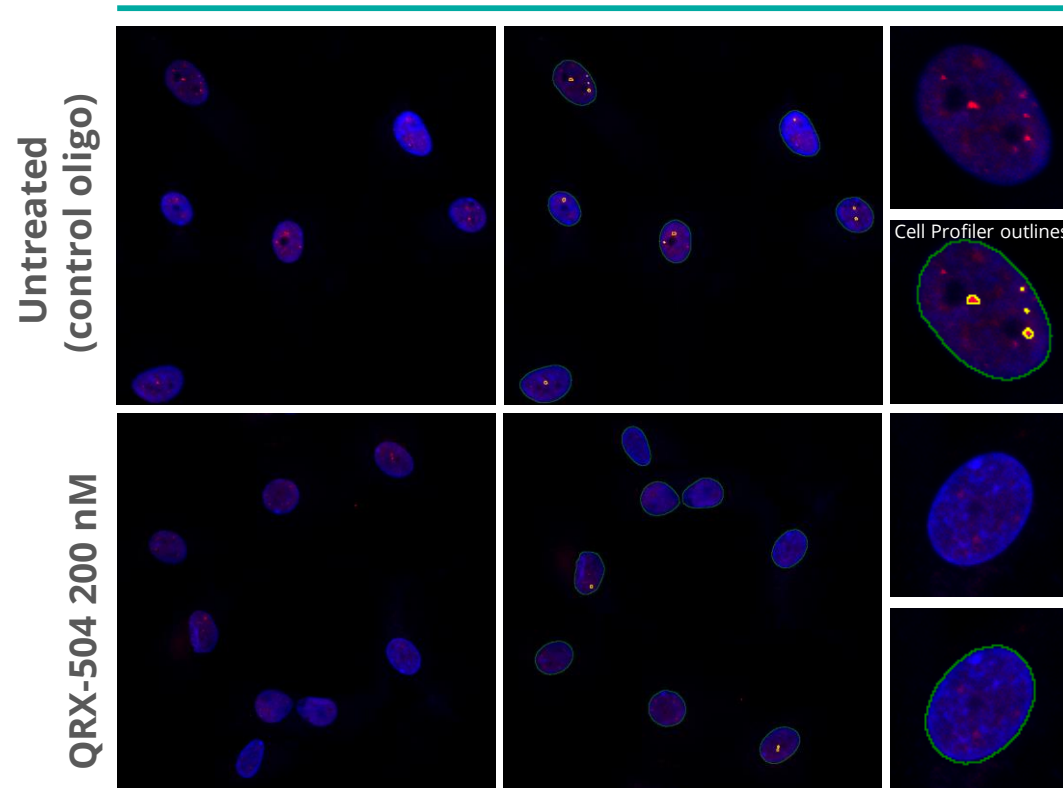
FECD



Control

QRX-504 reduces RNA foci in FECD CEC

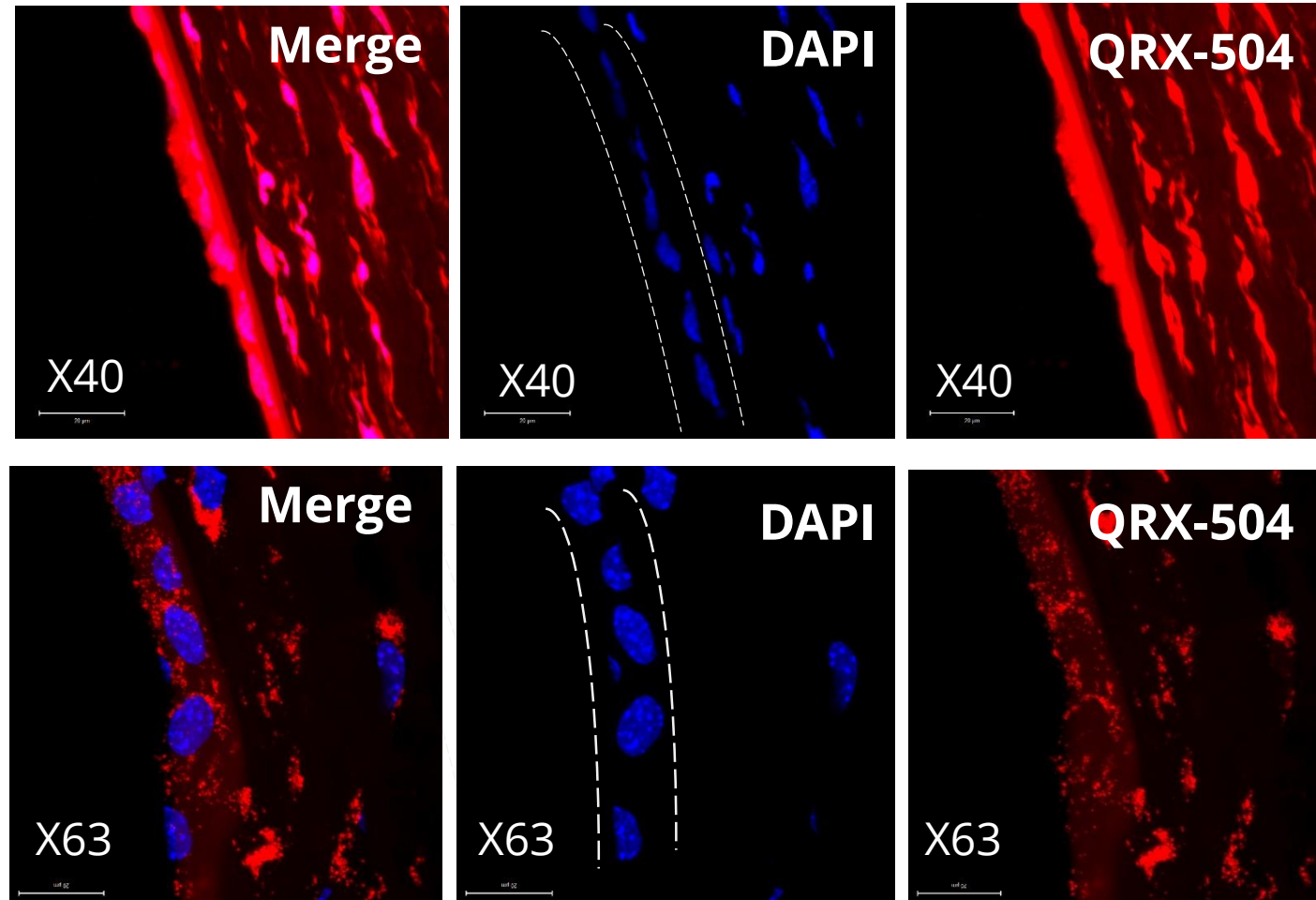
FECD CEC



Oligo delivery to corneal endothelium

IVT administered QRX-504 shows robust uptake

Cy3-labelled-
QRX-504



QRX-504 status and overview

- ✓ Single stranded oligo nucleotide resulting in reduction of RNA foci in FECD CEC cells
- ✓ Delivery to corneal endothelium through intravitreal administration
- ✓ Lead compound selected



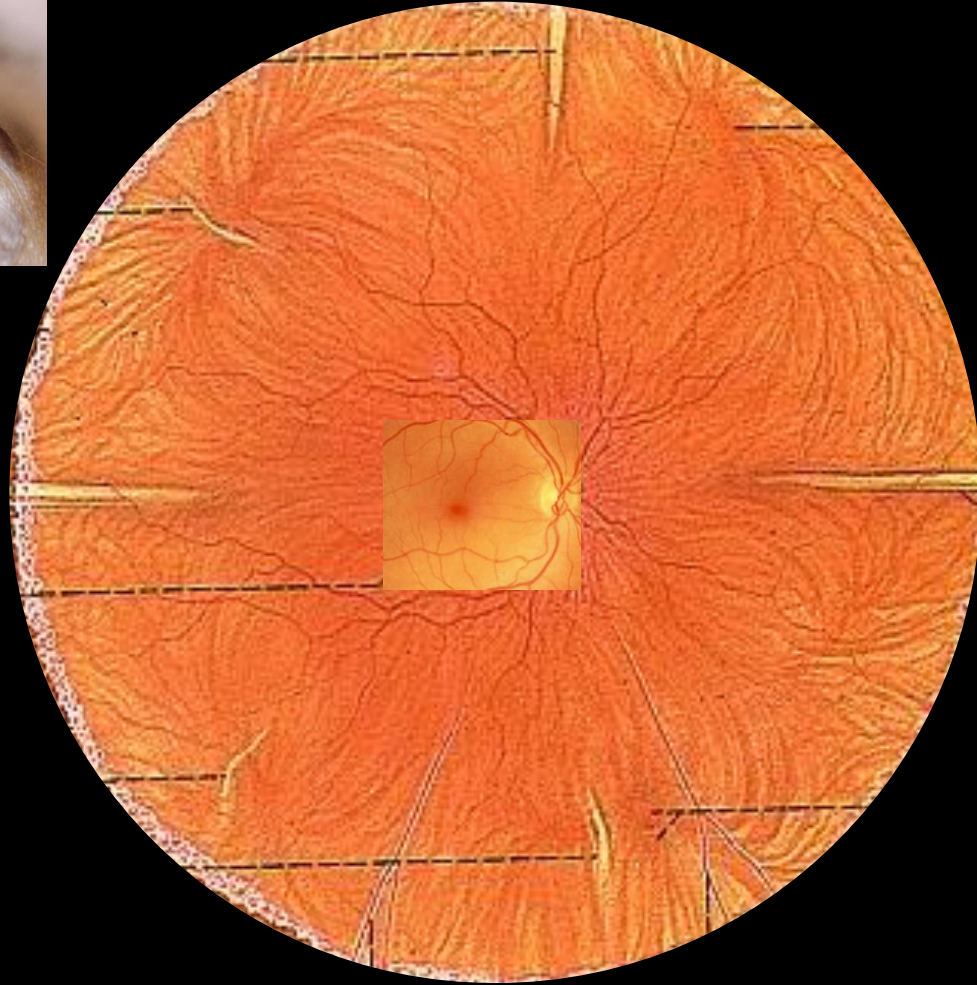
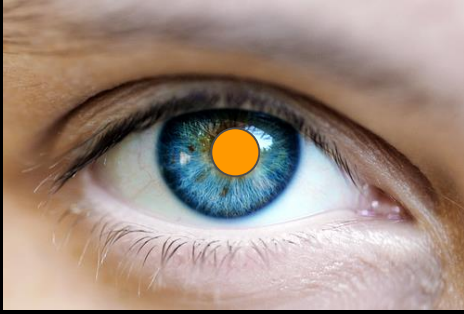




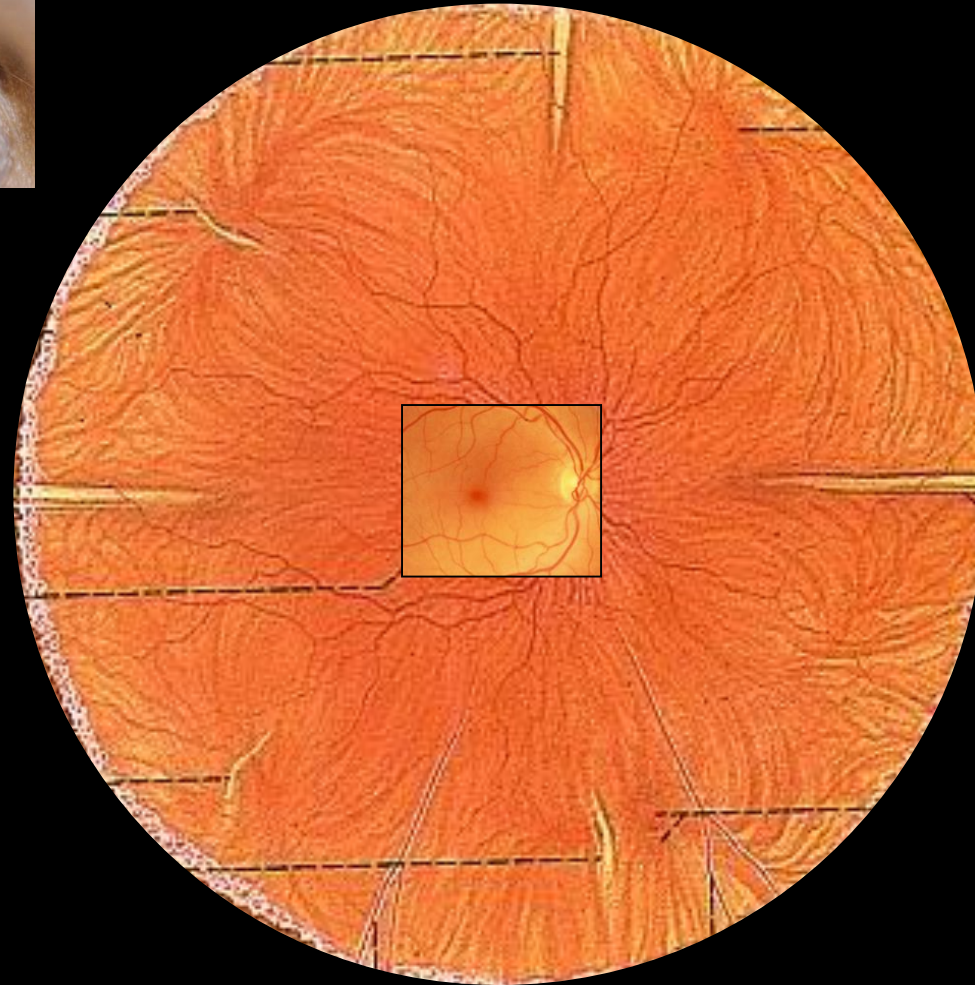
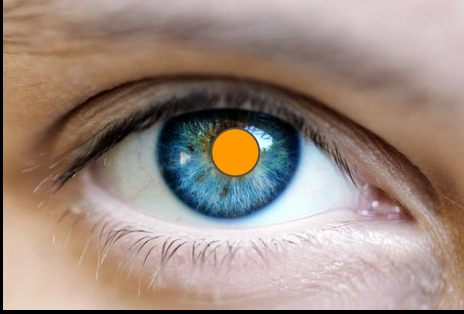




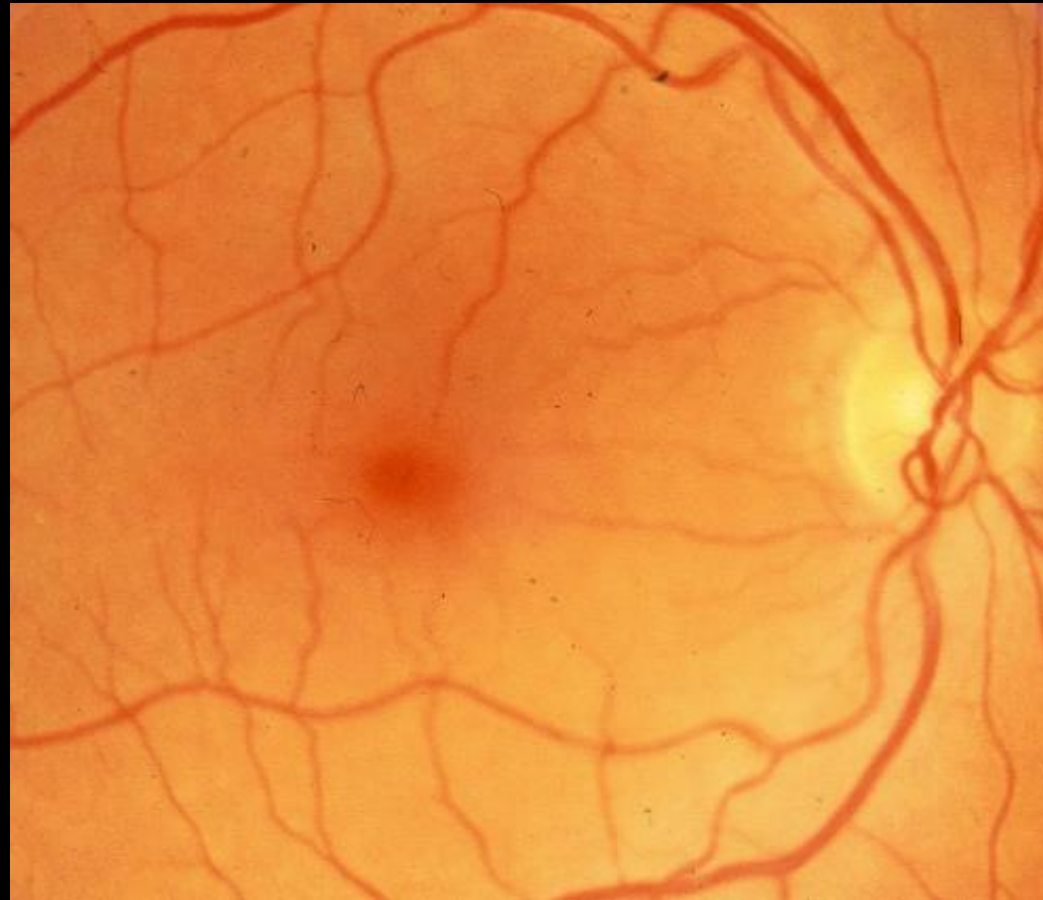
The Retina



The Retina

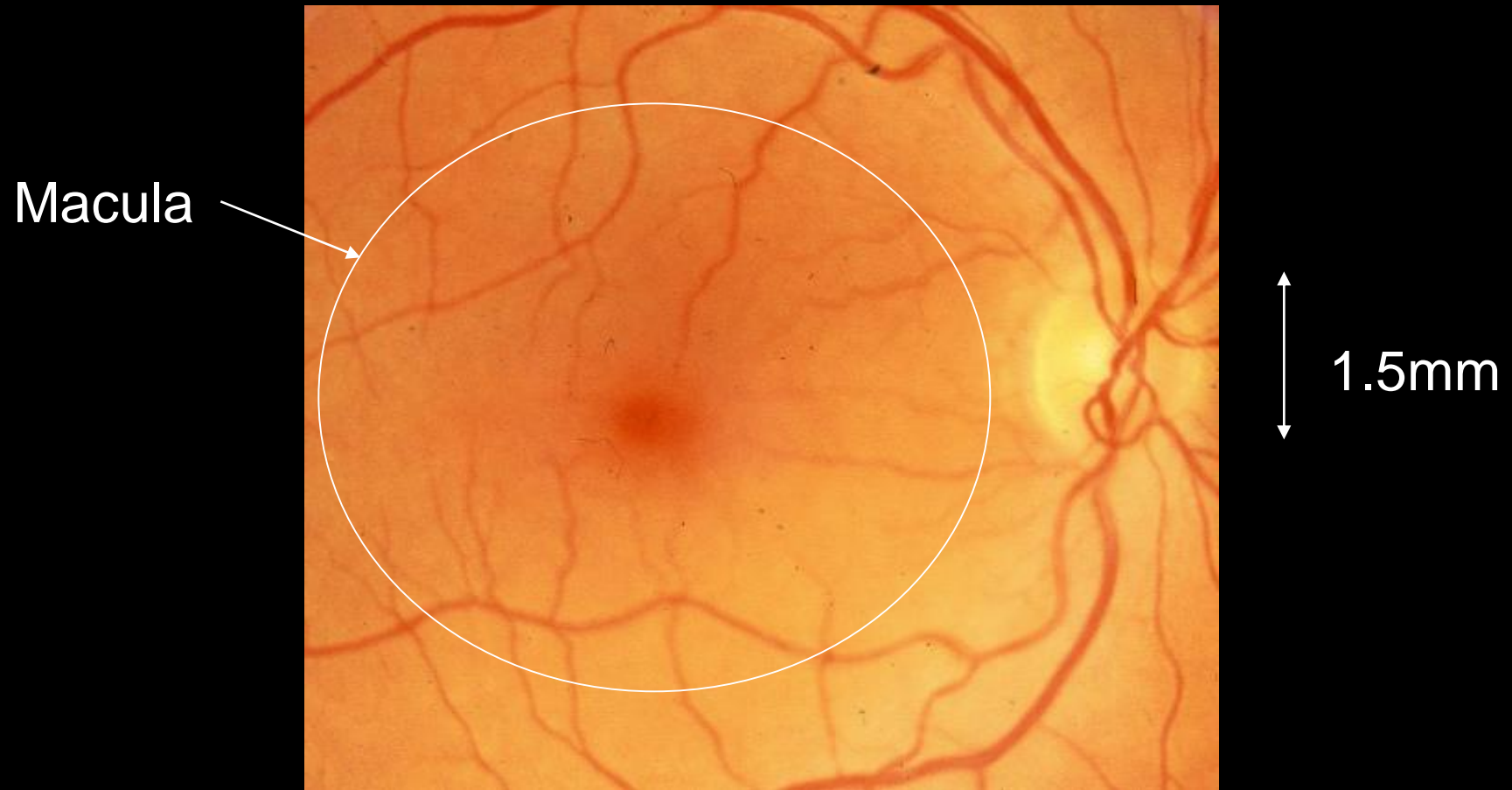


Macula

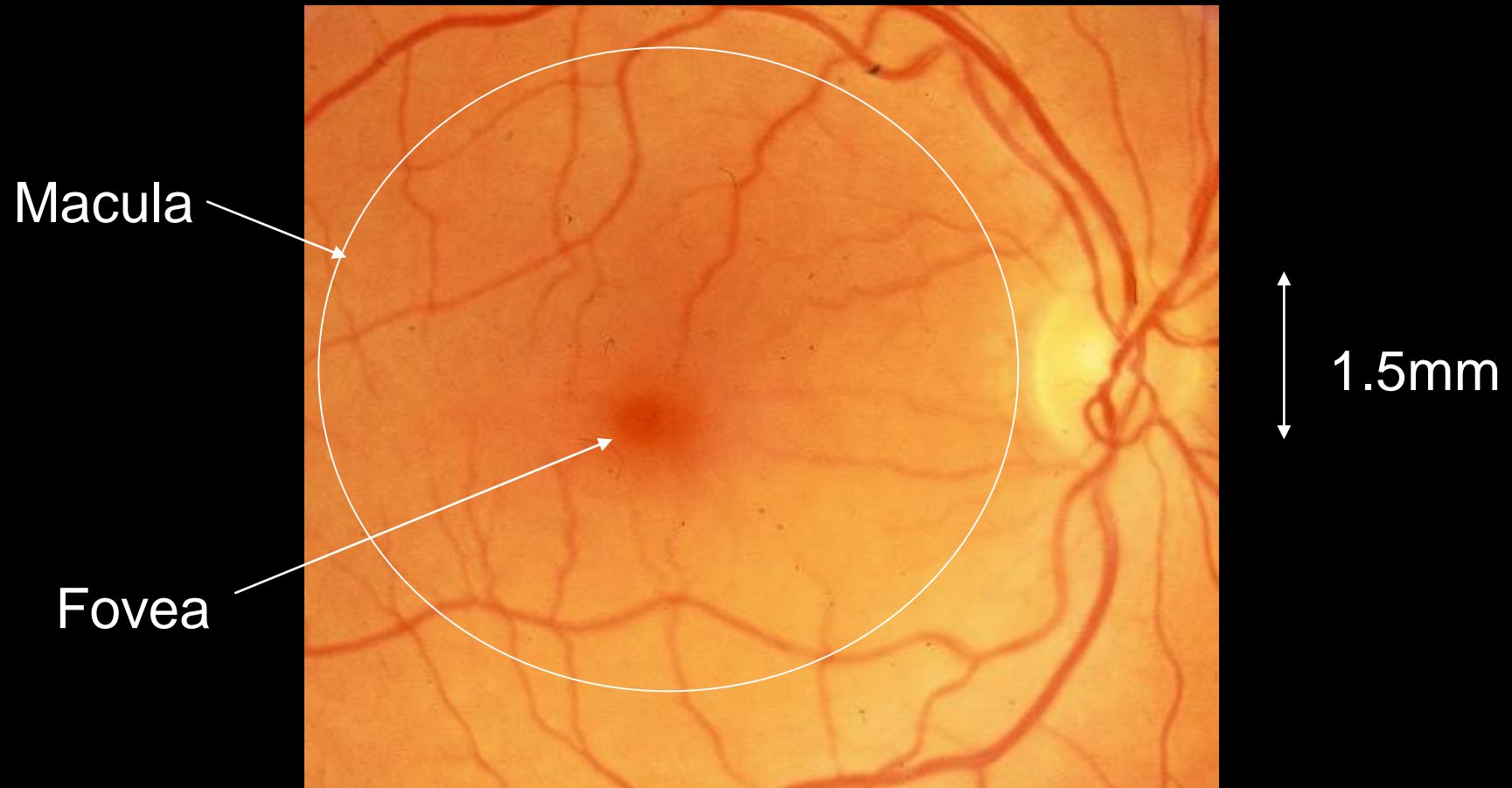


1.5mm

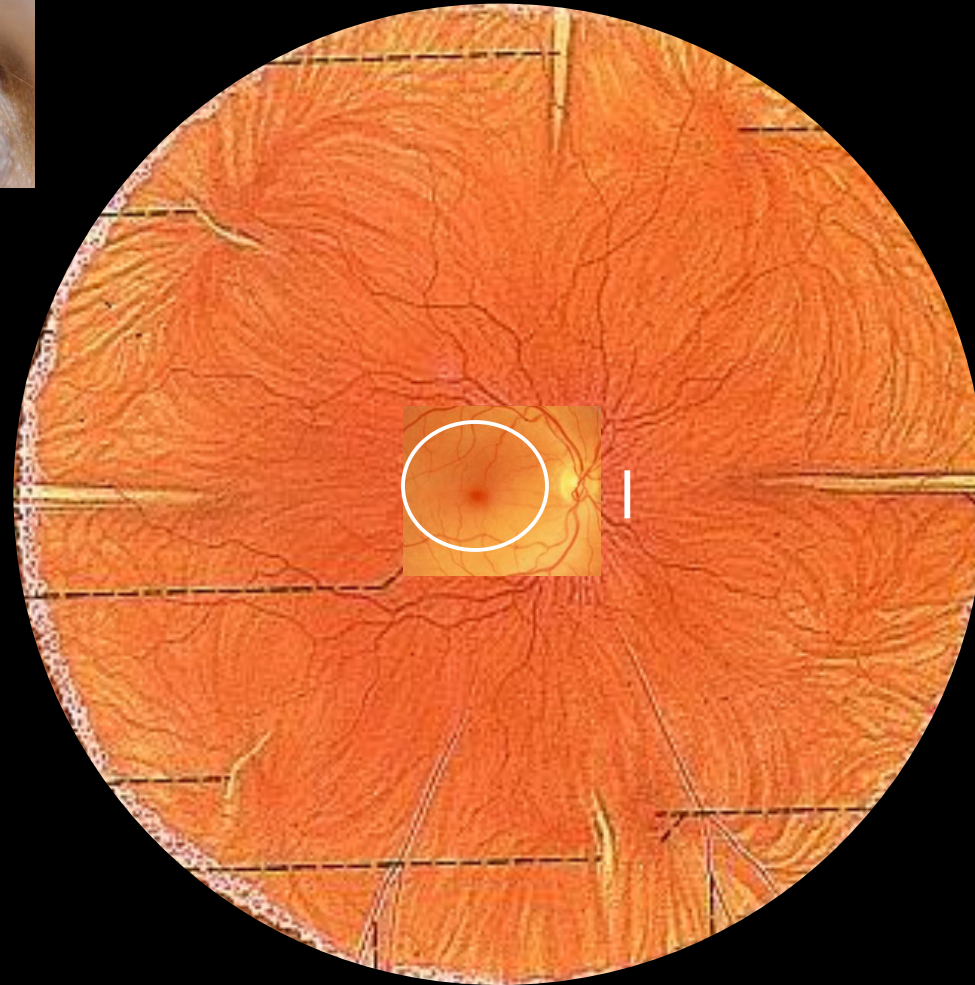
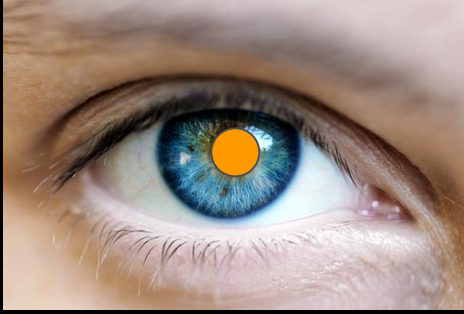
Macula

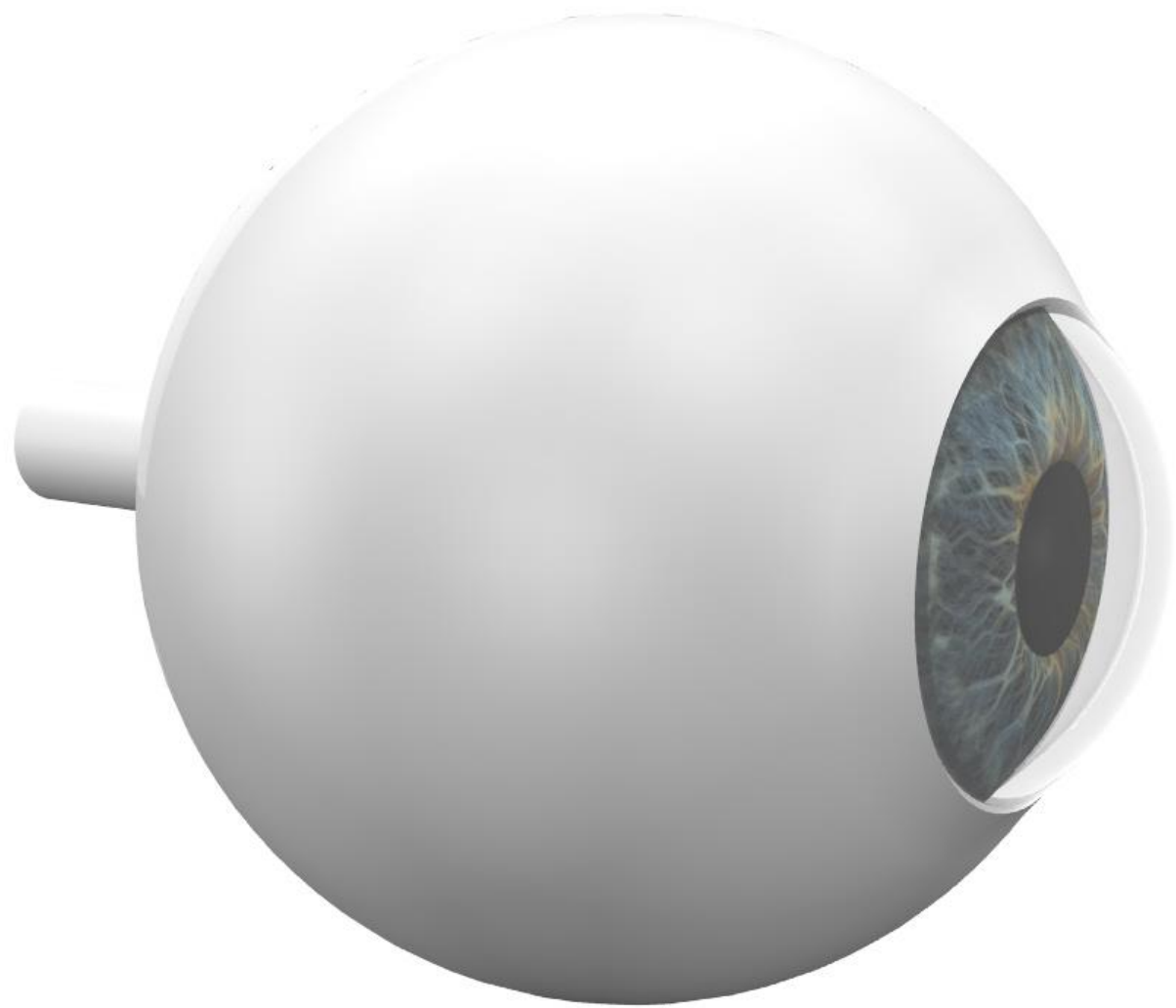


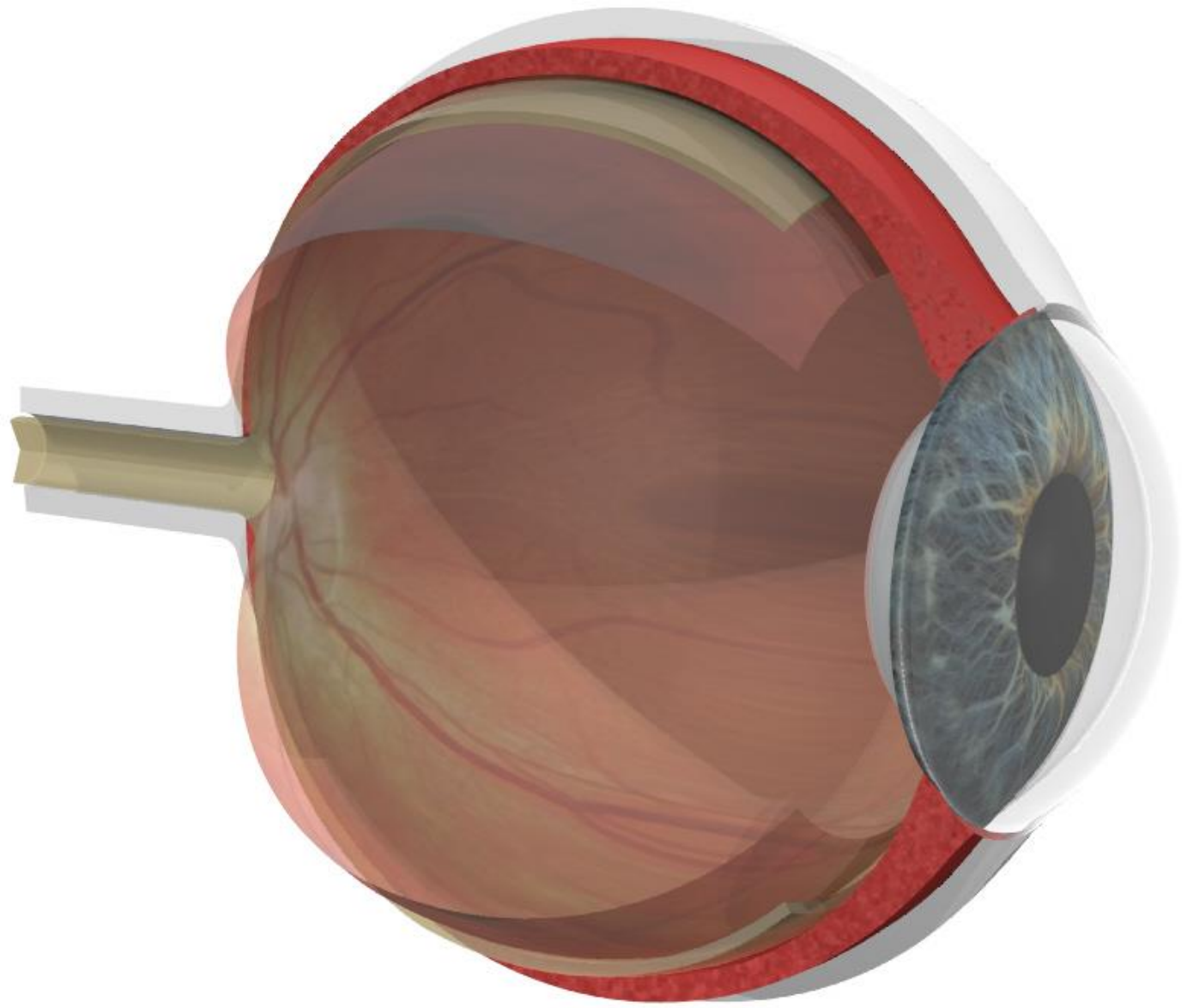
Macula



The Retina







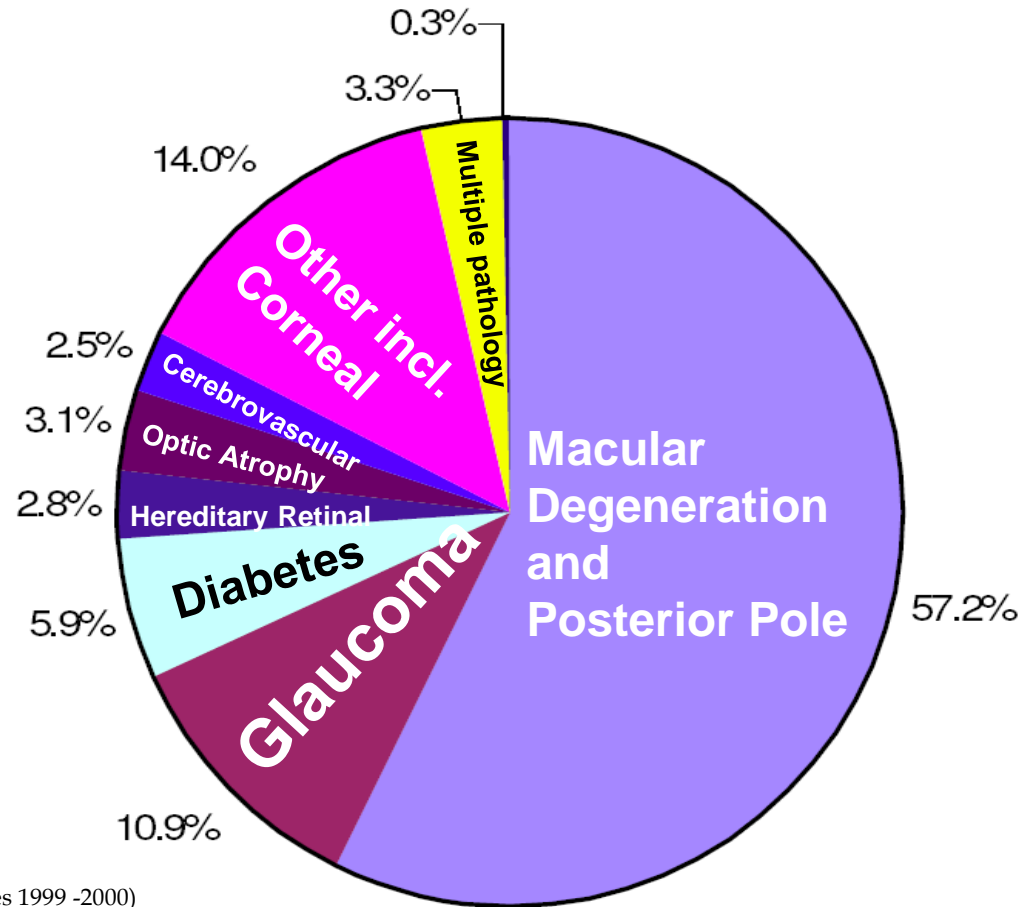
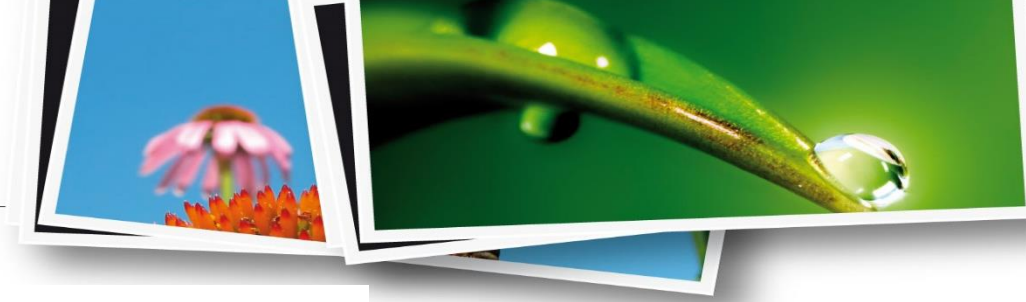
Sight loss



- In 2010 WHO estimated that 265 million people worldwide were visually impaired.
- In the UK today, 2 million people suffer from sight loss.
- Over 250 genes have been mapped to retinal disease (and we have discovered more than any other lab).

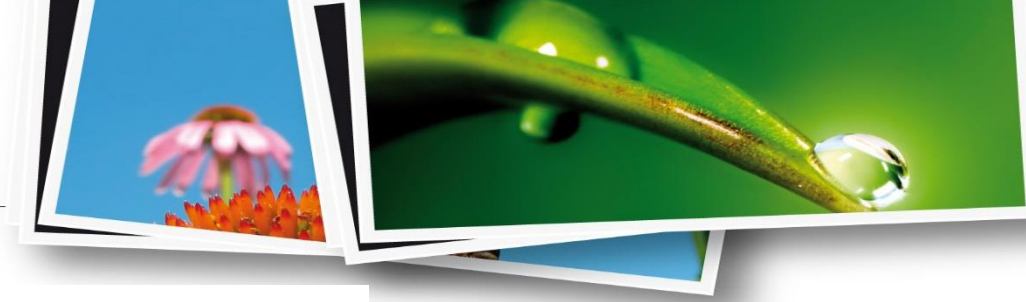


Major Causes of Blindness



Causes of Blindness (England and Wales 1999 -2000)
Bunce Wormald BMC Public Health 2006

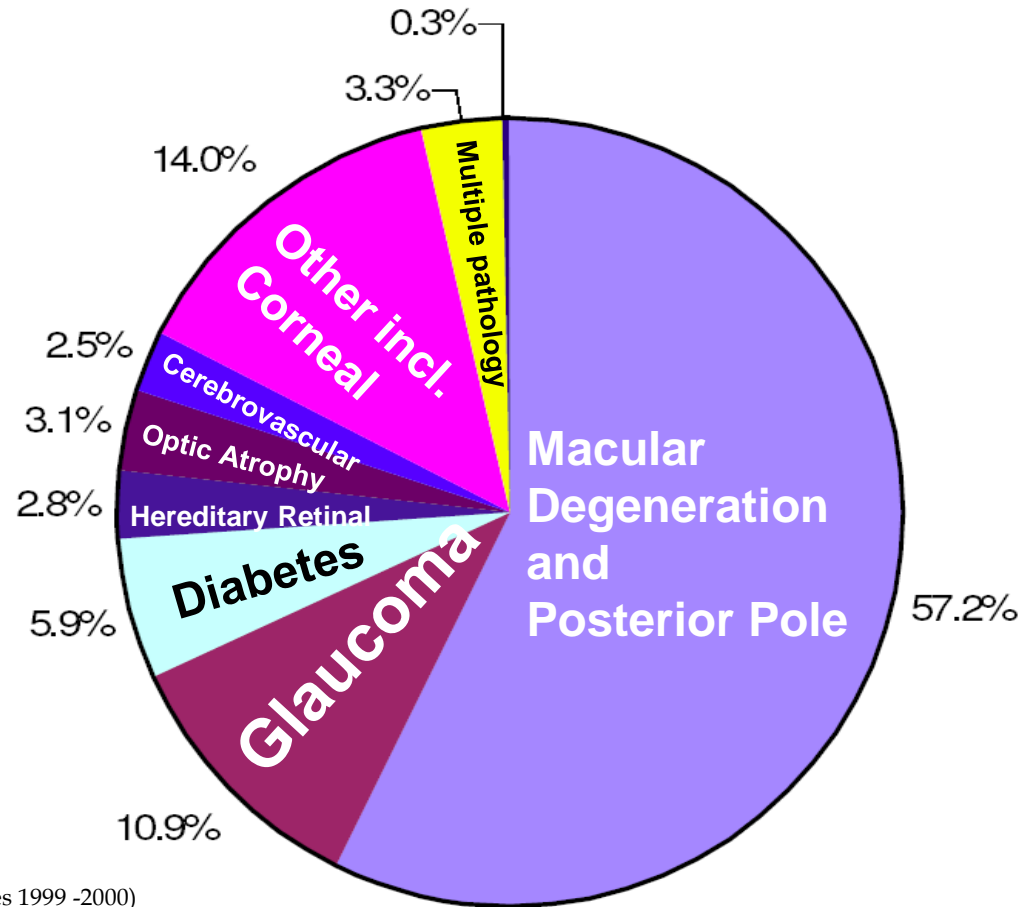
Advances in Innovation



Visual assessment
and imaging

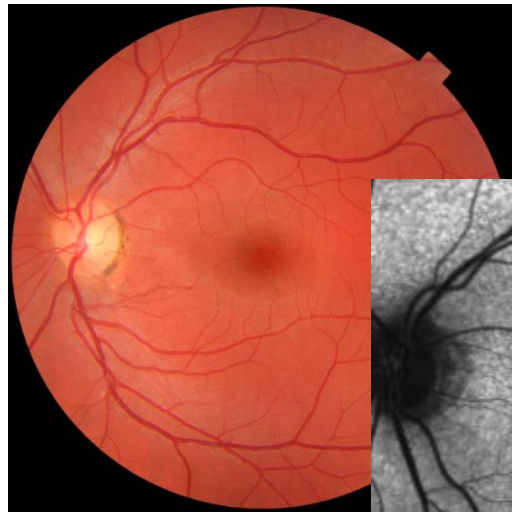
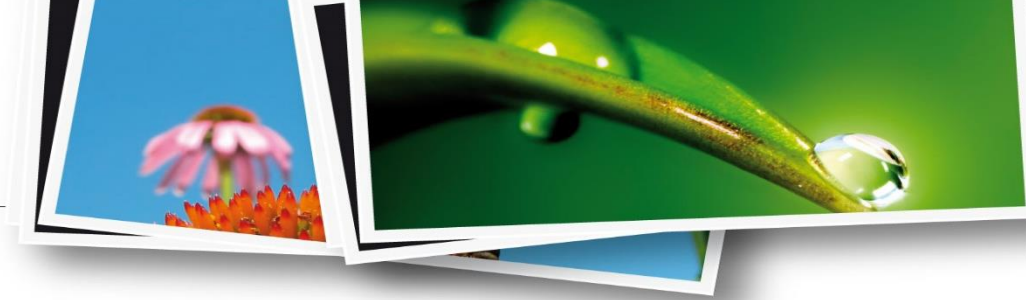
New Technologies
& Devices

Genotyping,
Phenotyping and
Informatics

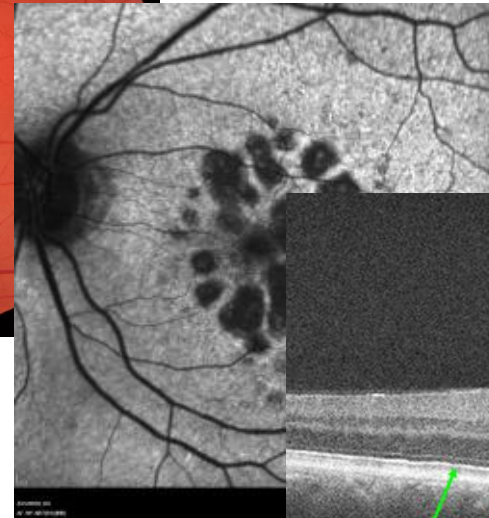


Causes of Blindness (England and Wales 1999 -2000)
Bunce Wormald BMC Public Health 2006

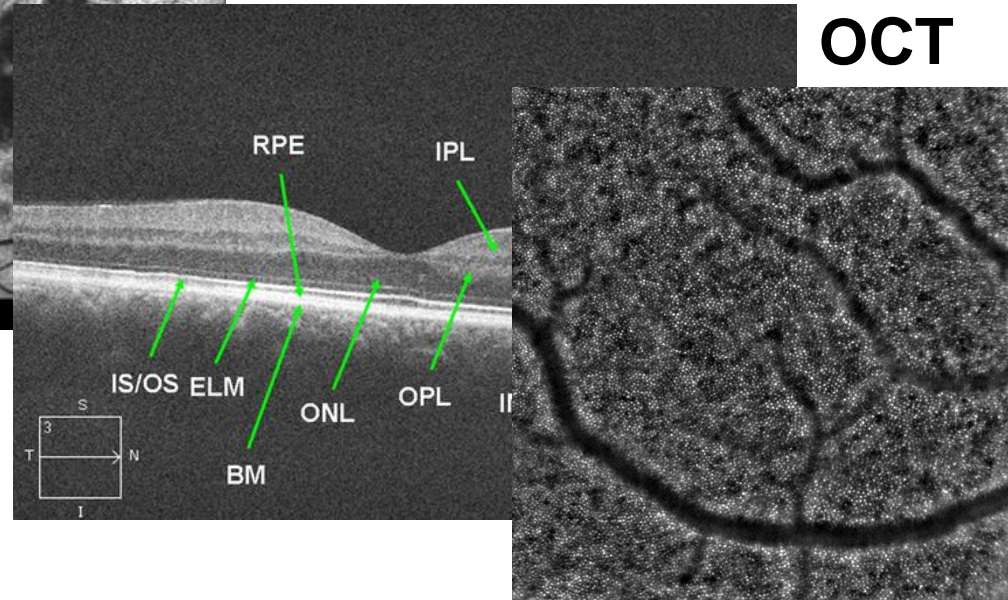
Imaging the Eye



Colour Photography



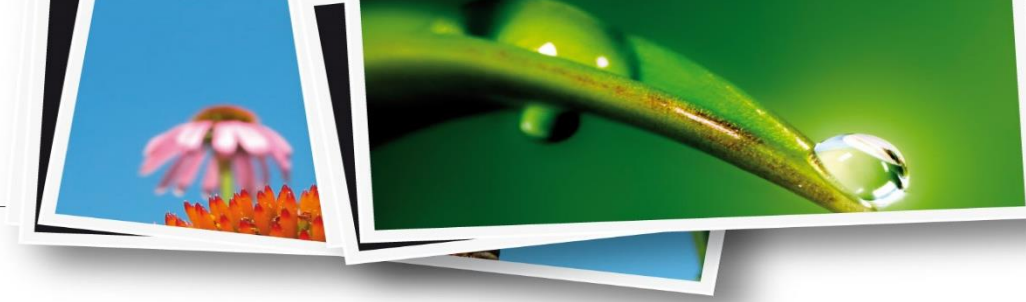
Flourescence



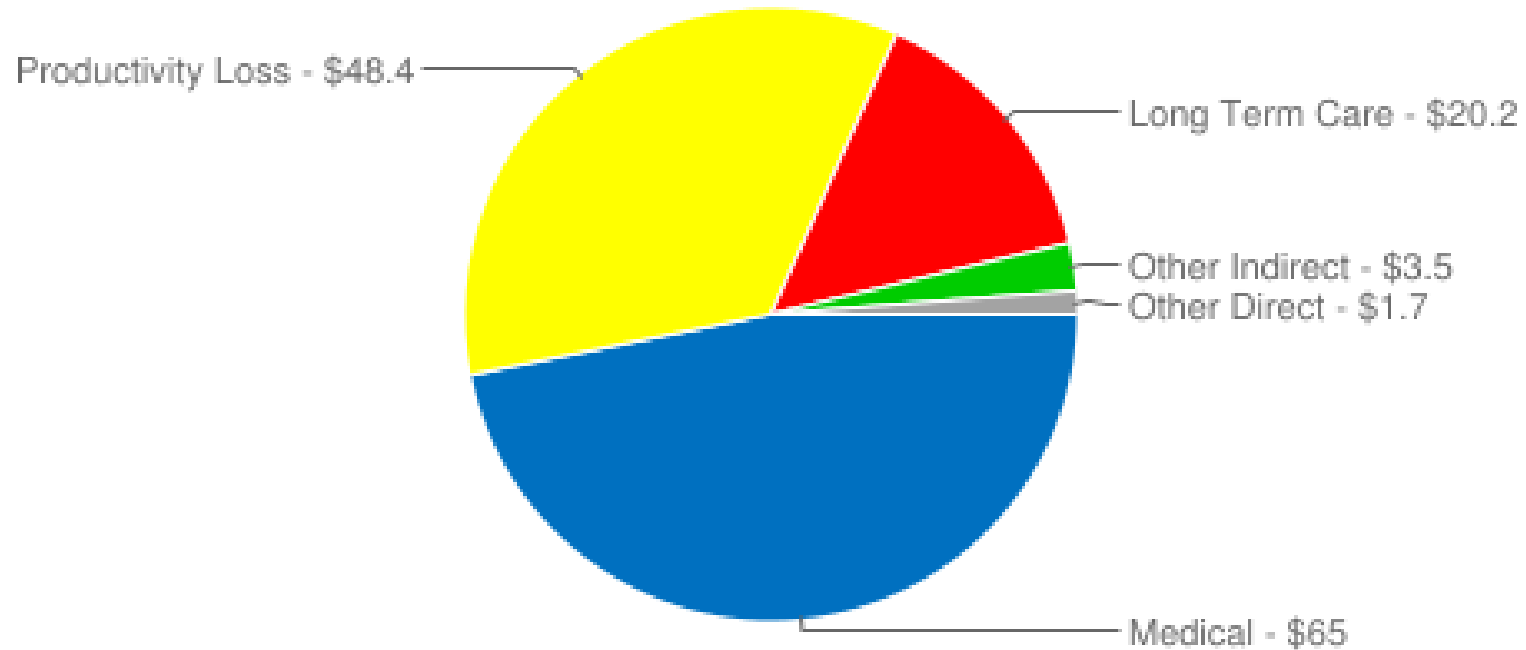
OCT

The Cost of Vision Problems

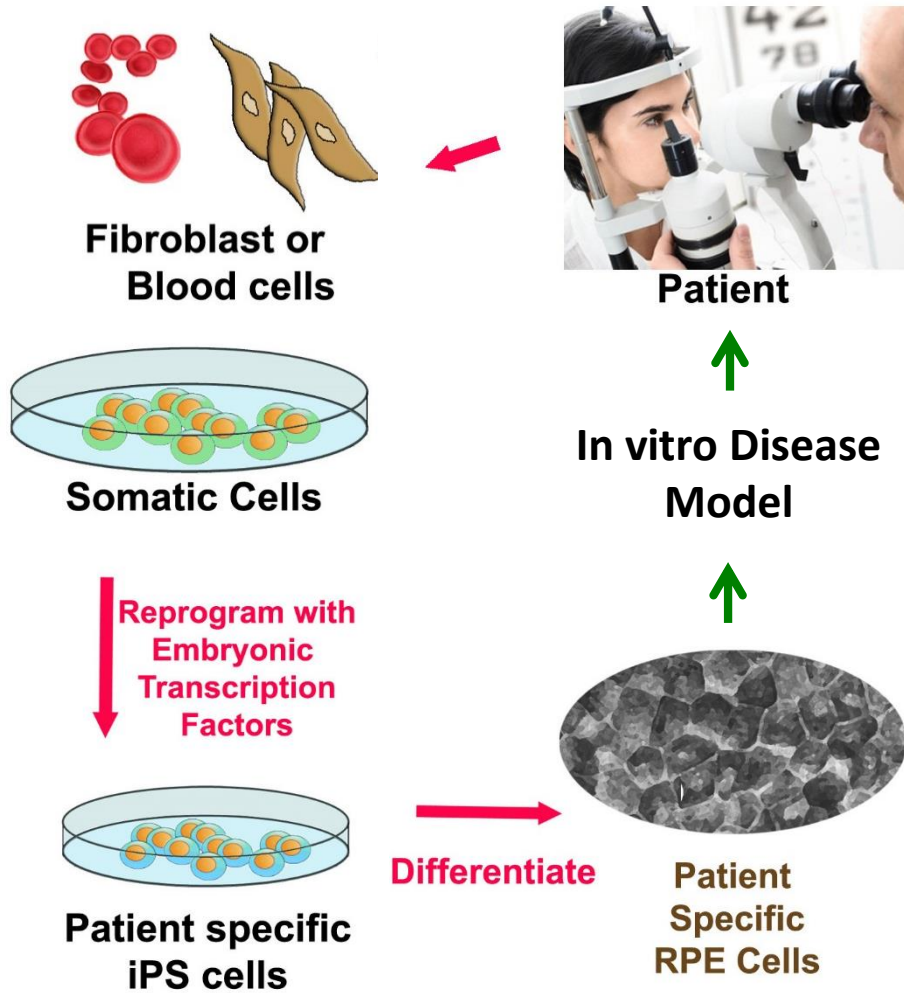
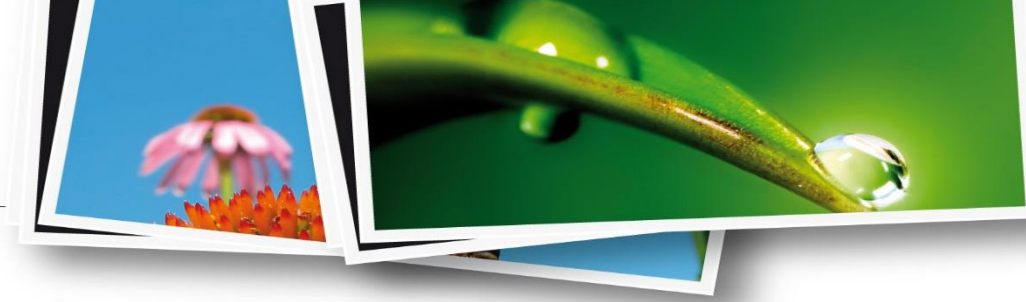
\$139 billion in direct and indirect costs



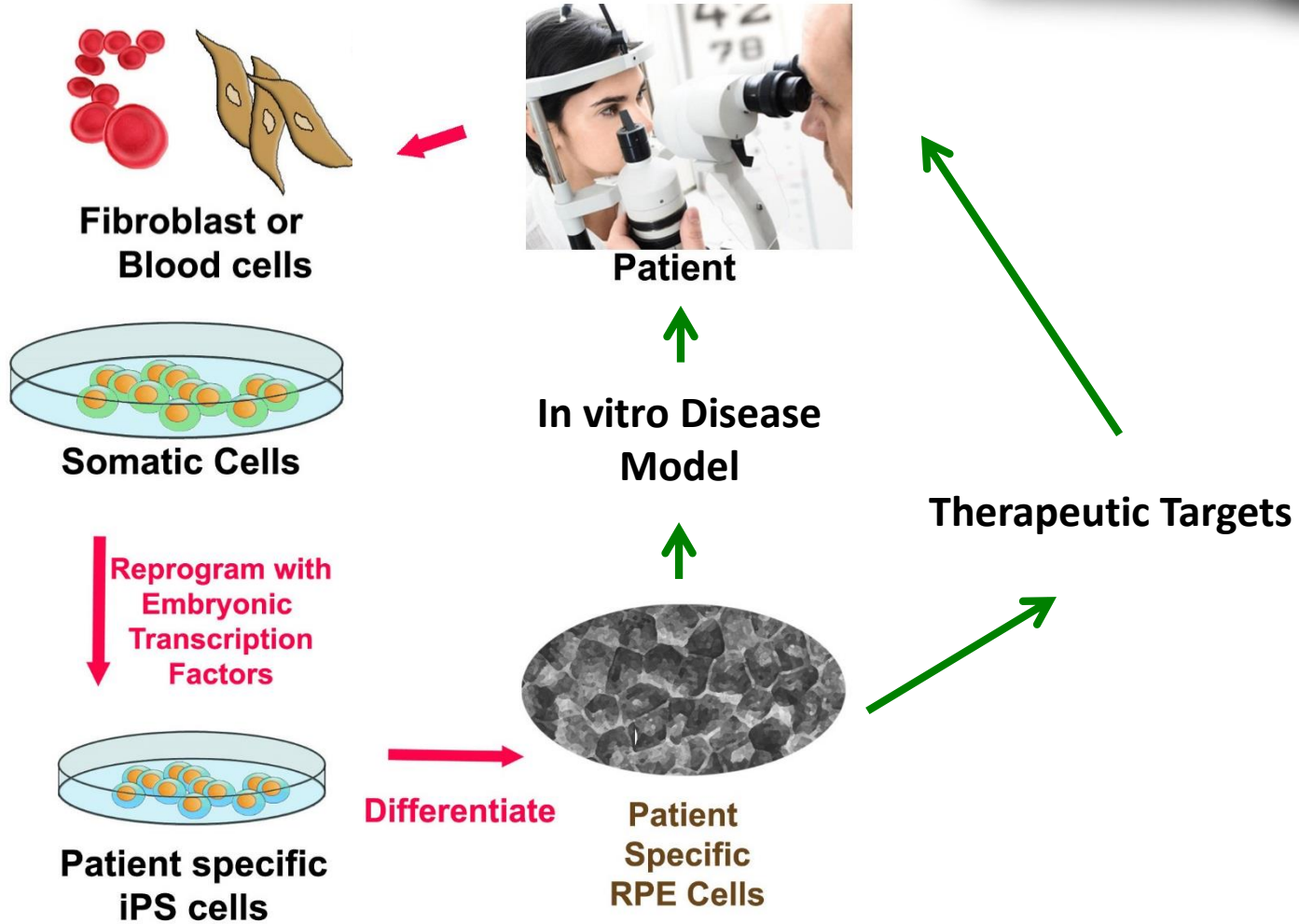
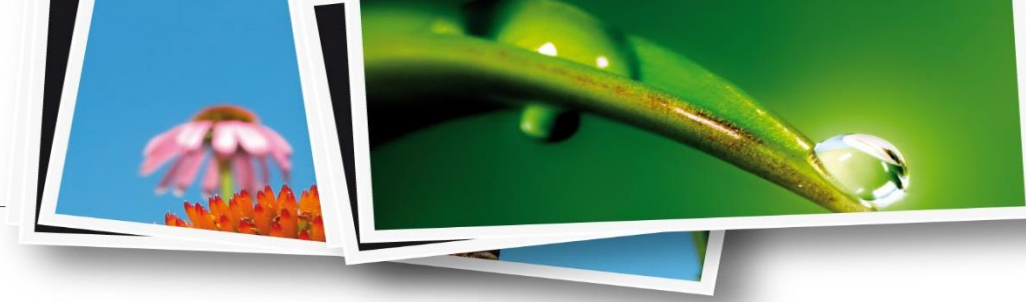
The 2013 Burden Estimate (in \$ billions)



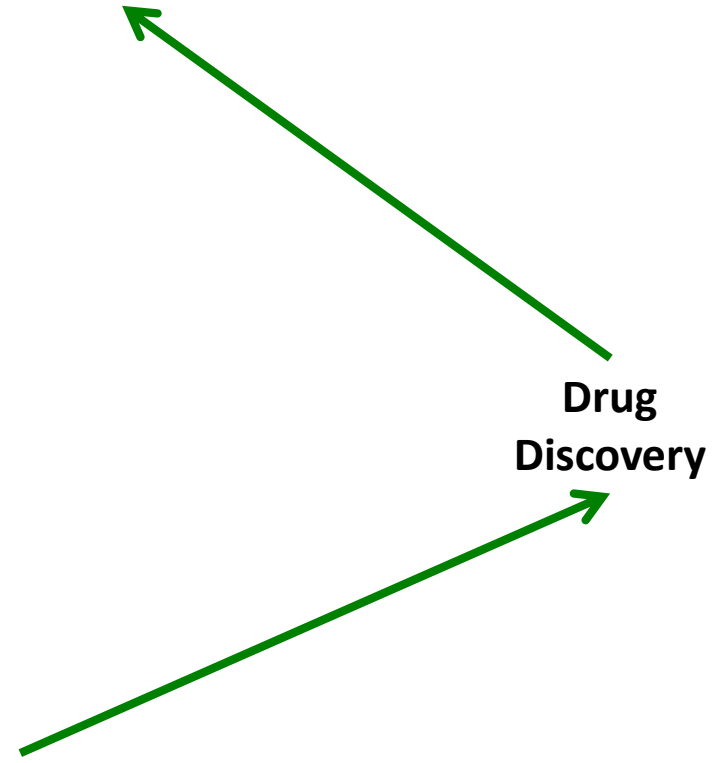
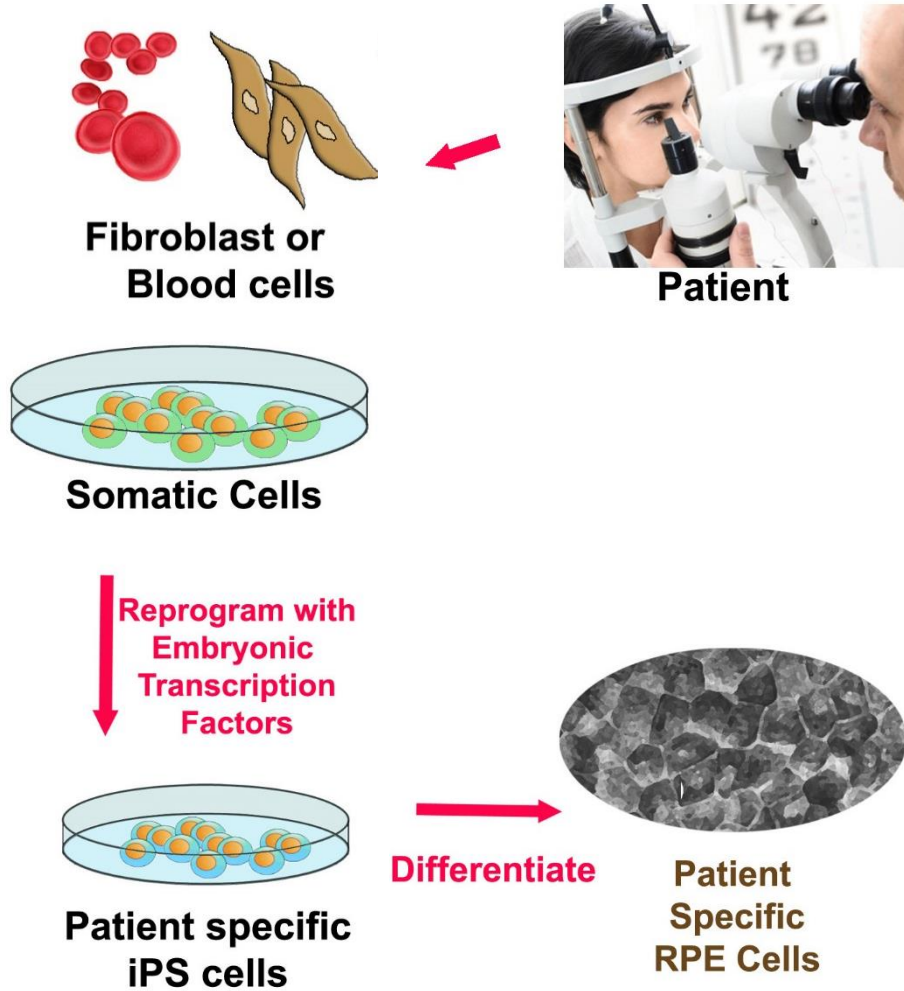
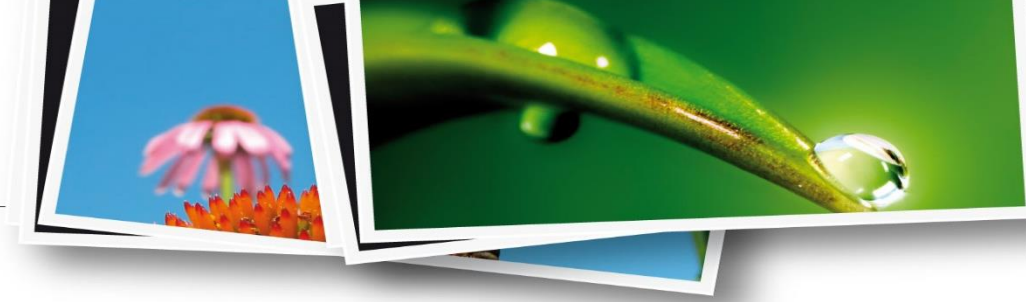
Phase 0: De-risking failure



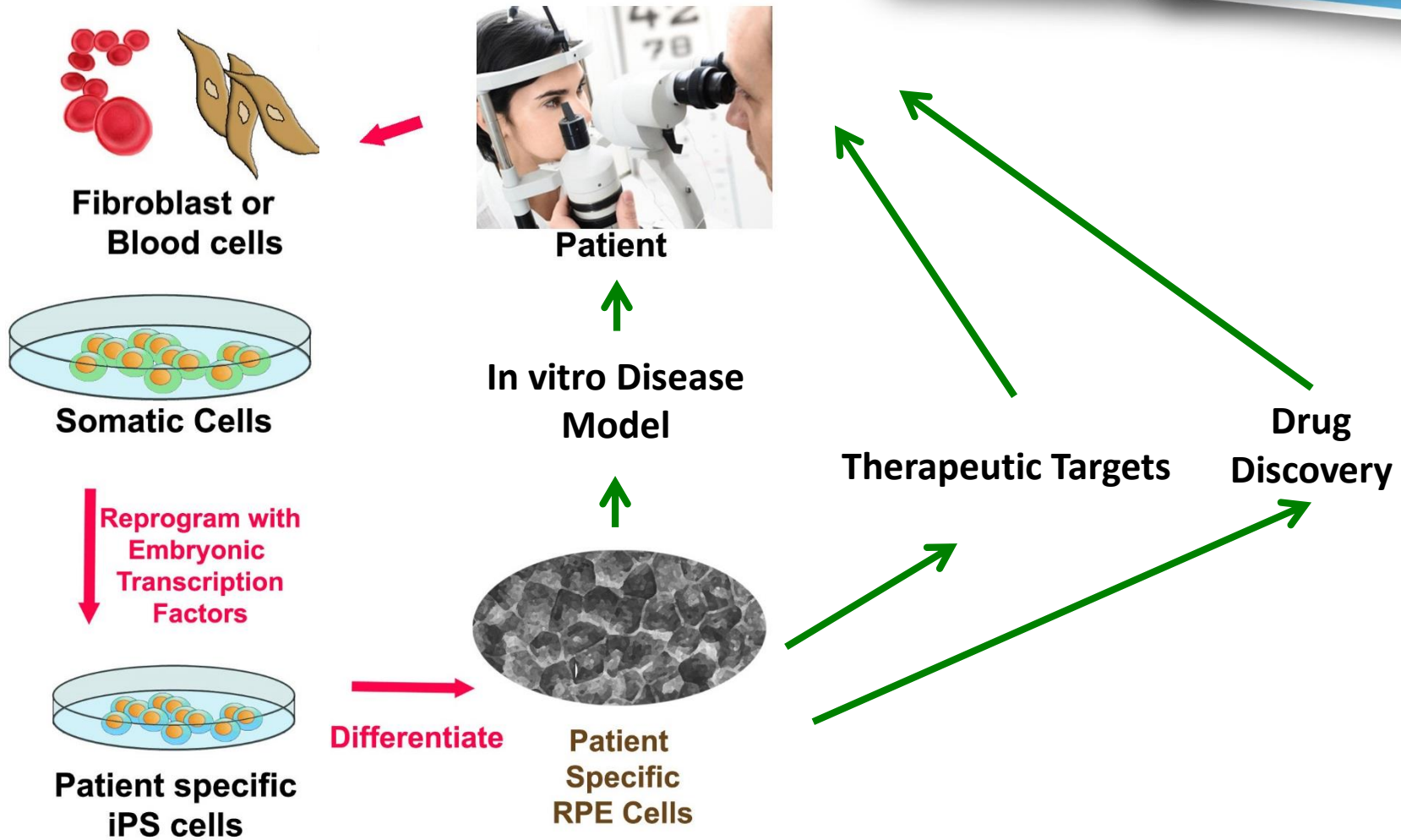
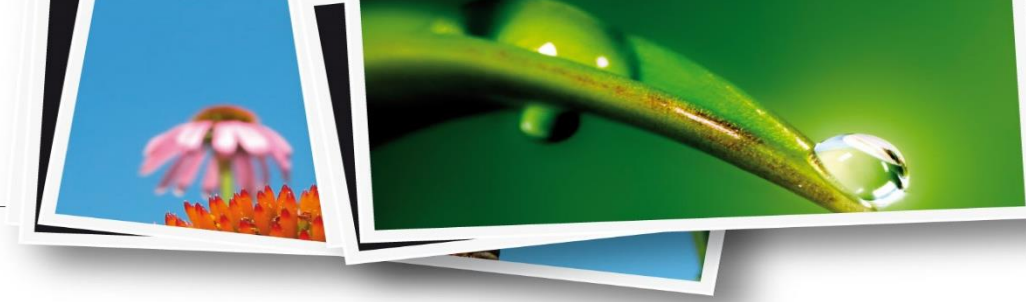
Phase 0: De-risking failure



Phase 0: De-risking failure



Phase 0: De-risking failure



Phase 0: De-risking failure

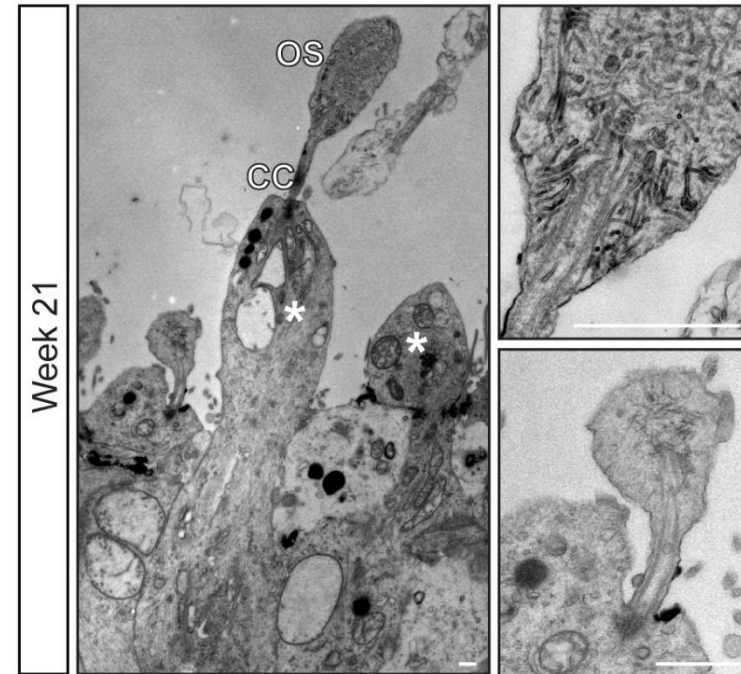
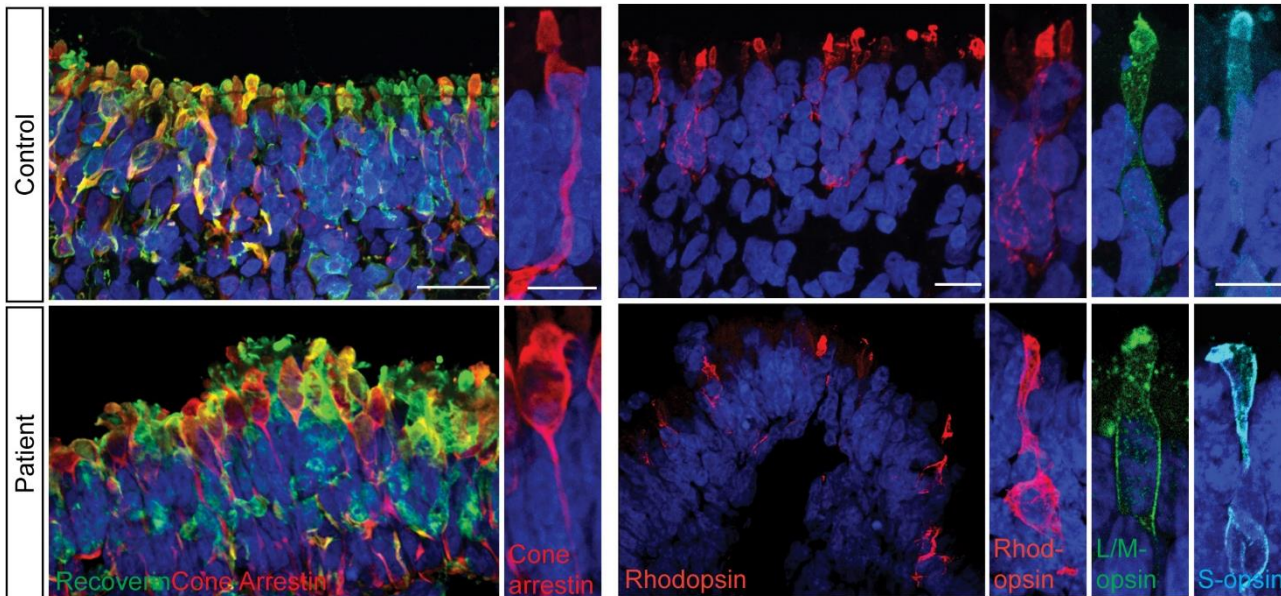
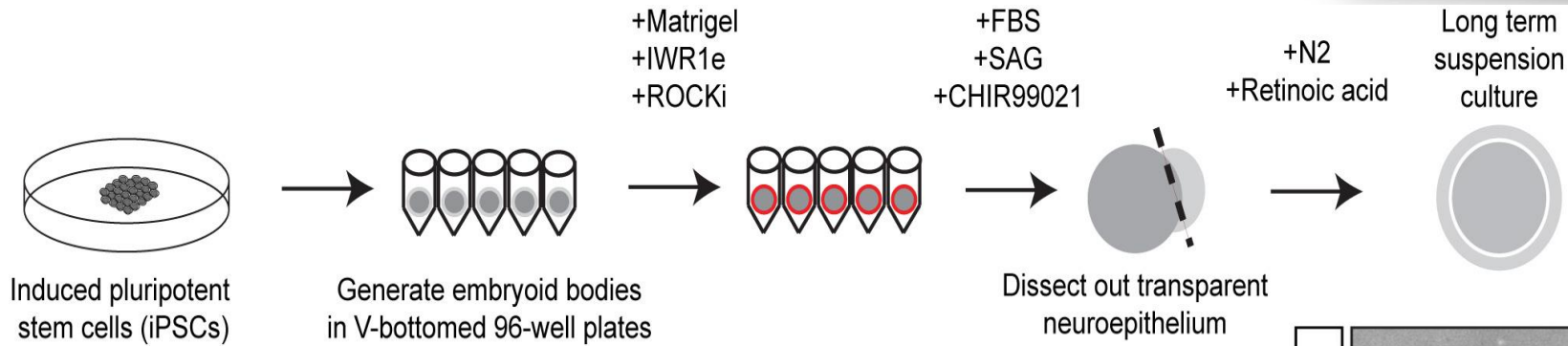
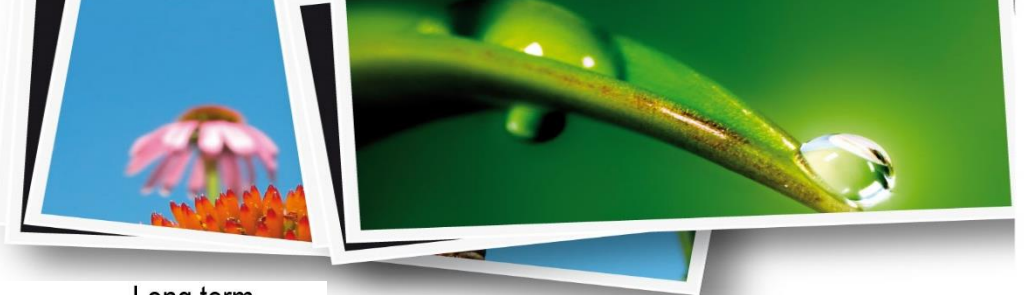


Gene	Disease	iPSC Lines
Best 1	Bestrophinopathies	✓
CFH	AMD	✓
RP2	Retinitis Pigmentosa	✓
MerTK	Retinal Cone Dystrophy	✓
REP-1	Choroideremia	✓
Stra6	Anphthalmia	✓
RAR α	Anphthalmia	Fibs
Cep290	Leber's Congenital Amaurosis	✓
Lrat	Retinal Cone Dystrophy	
Rdh5	Fundus Albipunctatus	
Timp3	Sorsby Fundus Dystrophy	
RPE65	Retinitis Pigmentosa	

Sample label	Y402H	I62V	E936D	L9H	intron 10	A69S	R130C	R176C	Isotype
HF 081309	YY	VI	EE	LL	TG	AA	TT	CC	$\epsilon 3\epsilon 3$
HF 082809 (20wk)	HH	VI	EE	LL	TG	AA	TT	CC	$\epsilon 3\epsilon 3$
HF 030411	YY	II	EE	LL	TG	AS	TT	CC	$\epsilon 3\epsilon 3$
HF 031611-1	YY	II	EE	LL	TG	AA	TC	CC	$\epsilon 3\epsilon 4$
HF 032411	YY	II	EE	LL	GG	AA	TT	CC	$\epsilon 3\epsilon 3$
HF 091511	HH	VV	EE	LL	GG	AS	TC	CC	$\epsilon 3\epsilon 4$
HF 110211	HH	VV	EE	LL	GG	AA	TT	CC	$\epsilon 3\epsilon 3$
HF 110912	YY	VI	DE	LL	GG	AA	TC	CC	$\epsilon 3\epsilon 4$
hF 120111	HH	VV	?	TT	GG	GT	?	?	?

Table 1. Current bank of induced pluripotent stem cell lines expressing relevant genes associated with AMD: Y402H – CFH, L9H – CFB, A69S – ARMS2/HTRA1 and R130C/176C – ApoE.

Phase 0: De-risking failure



Clinical Outcome



EDTRS

N C K Z O

R H S D K

D O V H R

C Z R H S

O N H R C

D K S N V

Z S O K N

SRZKD
H20V0
KYDOK
V0000
V0000

VVS

Snellen

E

1 20/200

F P

2 20/100

T O Z

3 20/70

P E D

4 20/50

E C F D

5 20/40

D F C Z P

6 20/30

F E L O P Z D

7 20/25

D E F P O T E C

8 20/20

L E F O D P C T

9

F D P L T C E O

10

P E Z O L C F T O

11

Government - Translational Medicine



Faster Cures
Early stage remuneration

George Freeman MP – Minister of Life Sciences
December 2015 MEH/loO Visit

Questions from the audience



Lunch Break

Presentations start
again at 12:50 PM EST

Epidermolysis Bullosa

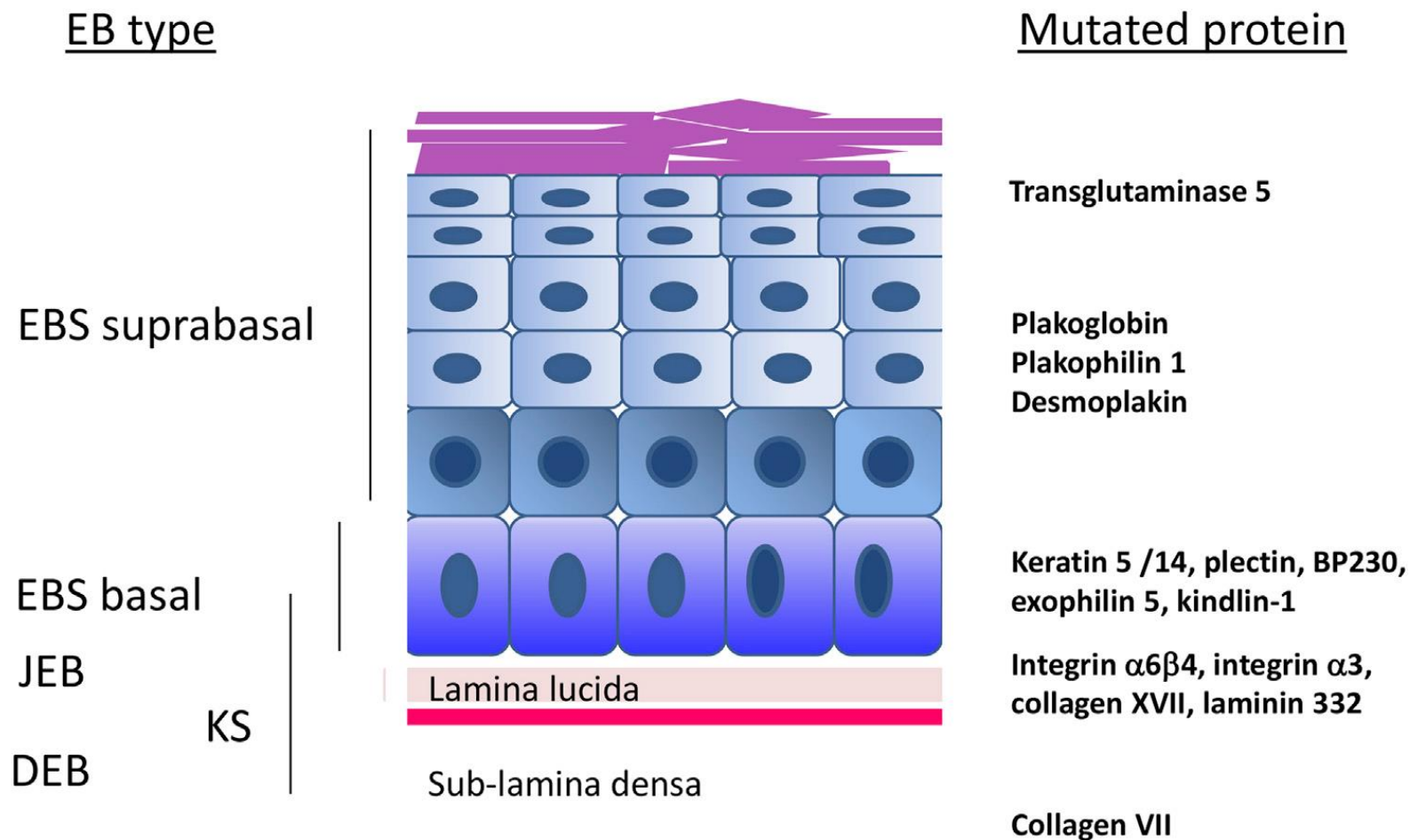
The Worst Disease You've Never Heard Of



debra
because the cost of doing nothing is too great

EB Definition – Onion Skin Approach

In 2014, there was an updated consensus on the classification of EB subtypes to further add clarification to the major types and subtypes. This approach took into account many factors including the level of skin cleavage, the phenotypic characteristics, the mode of inheritance, the targeted protein, and the gene involved with mutation present, to name a few.



EB Definition – Simplex

If only it was easy enough to say there were two subtypes, suprabasal and basal.



Suprabasal

Suprabasal EBS has 6 subtypes

There are 7 structural proteins potentially affected

Example:

EBS – Suprabasal - Acral peeling skin syndrome

Transglutaminase 5

Known mutations on TGM5 gene

Missense, deletion, small deletion/insertion

Basal

Basal EBS has 11 subtypes

There are 6 structural proteins potentially affected

Example:

EBS – Basal - Generalized Severe

Keratin 5 or Keratin 14

Known Mutations on K5/K14 genes

Missense, deletion, splice, nonsense, small deletion/insertion, insertion

EB Definition – **Dystrophic**

2 major subtypes, 14 subtypes – 1 affected protein – Collagen VII



Dominant

Dominant has 6 subtypes

Known mutations on COL7A1 gene

Missense, splice and deletion

Recessive

Recessive has 8 subtypes

Known mutations on COL7A1 gene

Missense, nonsense, deletion, splice, insertion, small deletion/insertion

Epidermolysis Bullosa - Definition

EB has been called a skin disease (because of its main symptom) and it's been called a group of disorders (because there are 4 major types and a large number of subtypes). Yet, neither properly defines the disease.



What is Epidermolysis Bullosa?

Epidermolysis Bullosa (EB) is a rare, genetic connective tissue disorder. There are many genetic and symptomatic variations of EB, but all share the prominent symptom of extremely fragile skin that blisters and tears from minor friction or trauma. Internal organs and bodily systems can also be seriously affected by the disease.

EB is always painful, is often pervasive and debilitating, and is in some cases lethal before the age of 30. The list of secondary complications can be long and may require multiple interventions from a range of medical specialists.

EB affects 1 out of every 20,000 live births and affects both genders and every racial and ethnic background equally. Those born with it are often called 'Butterfly Children' because as the analogy goes, their skin is as fragile as the wings of a butterfly.

There is no treatment or cure. Daily wound care, pain management and protective bandaging are the only options available.

By the numbers....

1 out of every 227 people has a defective gene that causes EB

There are about 25,000 people in the US with EB

There are about 30,000 in Europe and 500,000 worldwide

About 200 children are born each year in the US with a form of EB

Complications – Frequency in RDEB

The following samples of frequencies of secondary complications show profound individual impairment and demonstrate the cavernous unmet need.

Frequency from total RDEB population

Anemia	Growth Retardation
54.4%	43.6%



Frequency of psuedosyndactyly

< 2 yrs old	2 – 6 yrs old	6 – 10 yrs old	10 – 18 yrs old	> 18 yrs old
25.64%	59.26%	77.42%	74.19%	73.47%

Frequency of contractures

< 2 yrs old	2 – 6 yrs old	6 – 10 yrs old	10 – 18 yrs old	> 18 yrs old
18.42%	33.33%	64.52%	70.97%	77.55%

Frequency of cutaneous scarring

< 2 yrs old	2 – 6 yrs old	6 – 10 yrs old	10 – 18 yrs old	> 18 yrs old
84.62%	100%	96.77%	100%	100%

25.5% of those with RDEB have Cardiovascular issues

Complications – Frequency in RDEB-GS

When narrowing the scope to RDEB-GS, the frequency rates become horrific. Compare these frequency rates to the general population and the burden of disease is staggering.

Frequency of musculoskeletal, hematologic and constitutional complaints

Anemia	Growth Retardation	Pseudosyndactyly	Other Contractures
79.8%	78.8%	86.3%	74.3%

Frequency of GI complaints

Dysphagia	Esophageal Web, Stricture or Stenosis	Constipation
83.2%	59.3%	60.6%

Frequency of Ocular complaints

Corneal Scarring	Corneal Abrasions or Blisters	Impaired Vision
35.4%	56.4%	19.6%

Frequency of Oral complaints

Microstomia	Ankyloglossia	Gingival Erosions & Blisters	Abnormal Enamel or Dysplastic Teeth	Excessive Caries	Premature Tooth Loss
71%	80.8%	89.9%	31.3%	54.7%	47.9%

Frequency of select additional physical findings in a longitudinal follow-up of randomized sample of RDEB-GS

Scarring	Milia	Nail Dystrophy	Alopecia	Hypotrichosis	Pseudosyndactyly	Other Contractures
97.3%	78.4%	97.3%	35.1%	21.9%	93.2%	85.1%

RDEB-GS – Cancer & Life Expectancy

Squamous Cell Carcinoma is curable in the general population, not in RDEB. People who suffer from RDEB are 26.6 times more likely to suffer at least one incidence of SCC.

CANCER

21.67% *Chance of developing SCC, if patient lives to 25 years old*

39.57% *Chance of developing SCC, if patient lives to 30 years old*

53.00% *Chance of developing SCC, if patient lives to 35 years old*



Life Expectancy

10% *Lost their battle before they were 10 years old*

40% *Succumbed by the age of 20*

72% *Passed away by the age of 30*

EB in Numbers – Incidence & Prevalence

Given the incidence rate of 1 in 20,000 live births and prevalence percentages, debra of America estimates the below numbers of patients.

**Estimates for Epidermolysis Bullosa (EB)
By Main Types and Subtypes
Numbers Are Still Extremely Under Reported**

	Incidence (# born per year)	Prevalence (# at any given time in population)
EB	200	21,107
Simplex	110	13,990
Localized	69	9,550
All Others	40	4,440
Junctional	21	1,338
Severe Generalized	4	213
Other	17	1,125
Dystrophic	50	5,779
DDEB	29	3,011
RDEB	21	2,768
- Severe Generalized	4	1,277
- Other	17	1,490

No Cure or Treatment – **But Hope**

As of today there is no cure or FDA approved treatment. Pain management, wound care, and preventative bandaging are the only options.



There is HOPE Currently under investigation

- *RNA Repair*
- *Gene Editing*
- *Gene Therapy*
- *Gene Transfer*

- *Grafting of Autologous Skin*

- *Protein Replacement*

- *Stem Cell Transplantation*

- *Topical Creams for Wound Healing*

Burden of Illness— **Financial Burden**

EB, and particularly the more severe forms, are incredibly expensive. Wound care supplies, hospital visits, surgeries, medications all are factors.

Wound Care Supplies

The specialized wound care dressings can cost more than \$15,000 per month. The average cost of these supplies are approximately \$125,000 per annum.

Hospital Visits

A child may need to receive blood transfusions every eight weeks to treat the anemia, and may require quarterly esophageal dilations to swallow liquid.

Assuming costs are:

Blood Transfusions - \$8,000
Esophageal Dilations - \$15,000

Annual cost = \$108,000

Drugs

The list of daily medications is extensive. It is difficult to calculate the cost but a list of medicines for an RDEB child could be:

Protonix, Methadone, Gabapentin, Carvedilol, Enalapril, Hydroxyzine, Lexapro, Lorazepam, Ferrous Sulfate, Zinc, Vitamin D



1 Month Supply of Wound Care Supplies
for an 8 year-old

Burden of Illness— **Bandage Changes**

It's impossible to truly understand what a person with EB undergoes daily. Bath and bandage changes can last 3 or more hours, are incredibly painful, and are likened to parents torturing their child.



Thank You



From All Of Us Living with EB





QRX-313

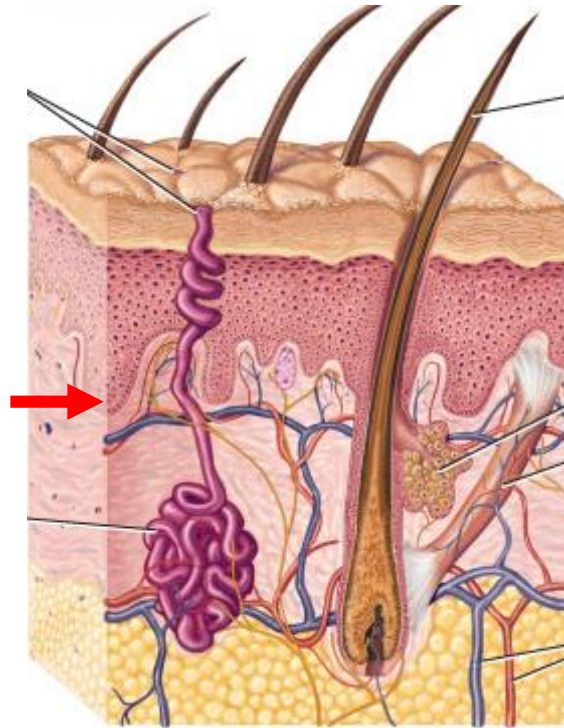
RNA modulation for dystrophic epidermolysis bullosa

Skin morphology

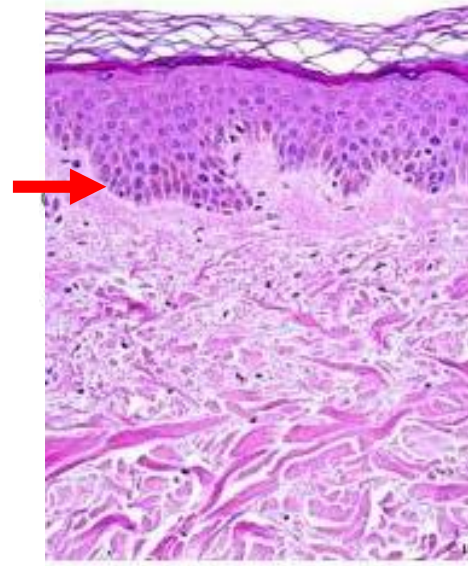
Stratum corneum
Epidermis

Dermis

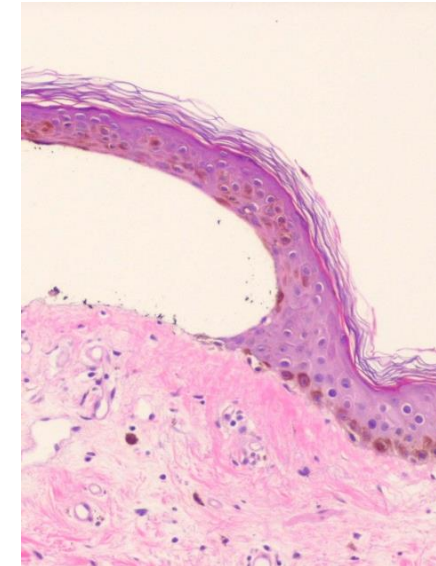
Subcutaneous fat



Healthy skin

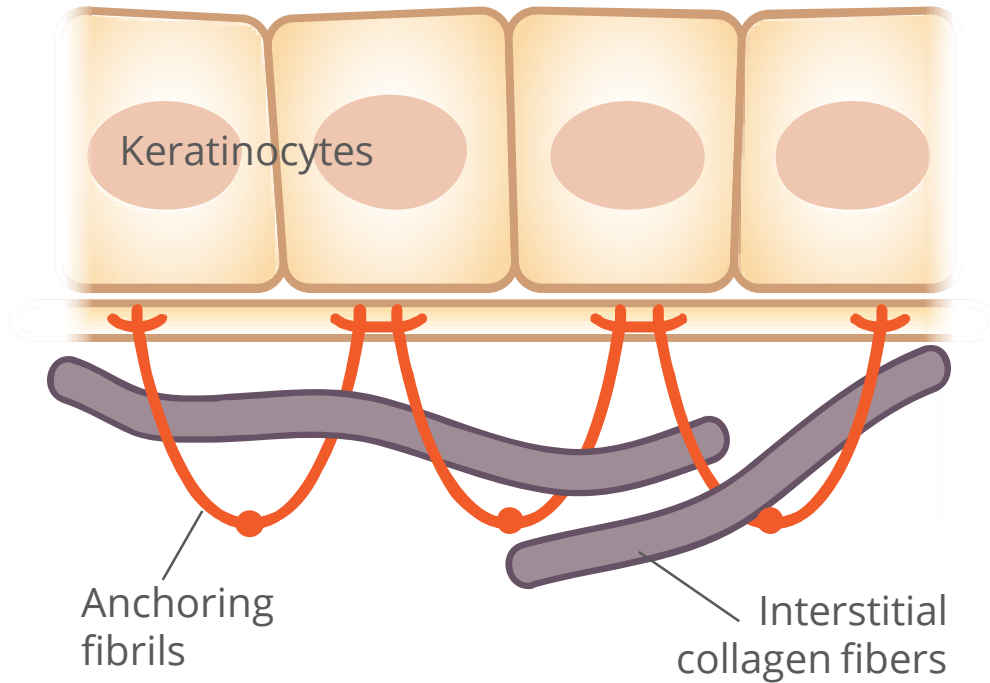


DEB skin

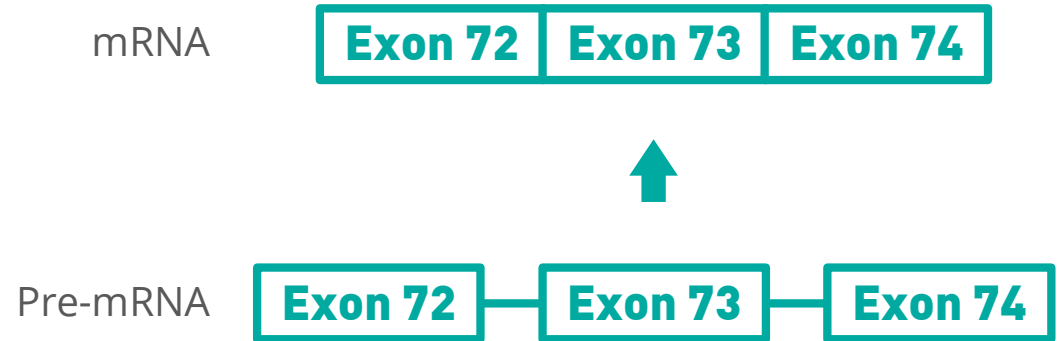


— Location Collagen type VII

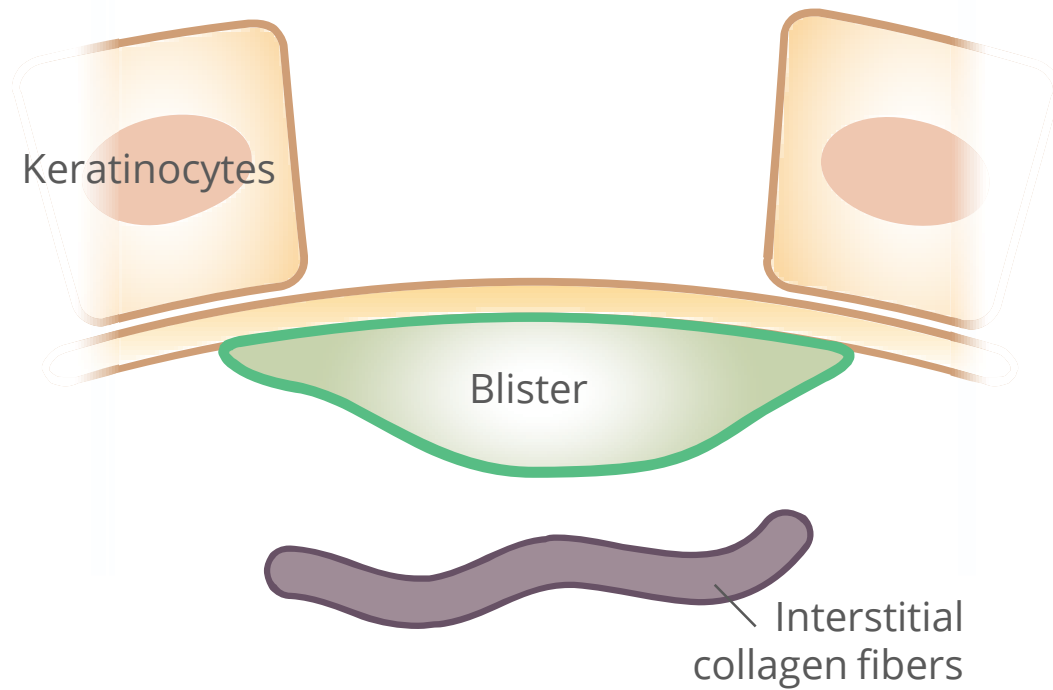
QRX-313 for DEB



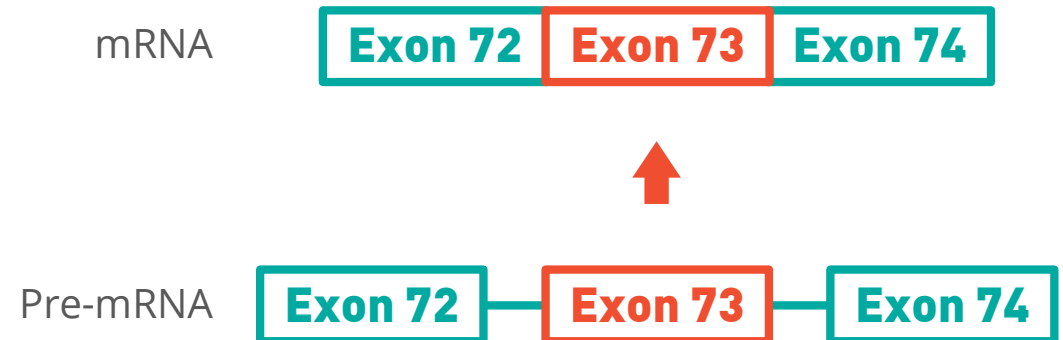
In healthy skin collagen VII forms anchoring fibrils that link skin layers



QRX-313 for DEB

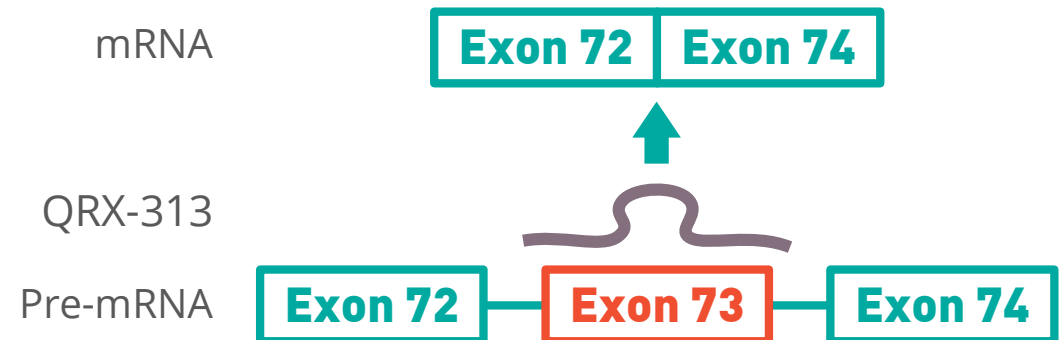
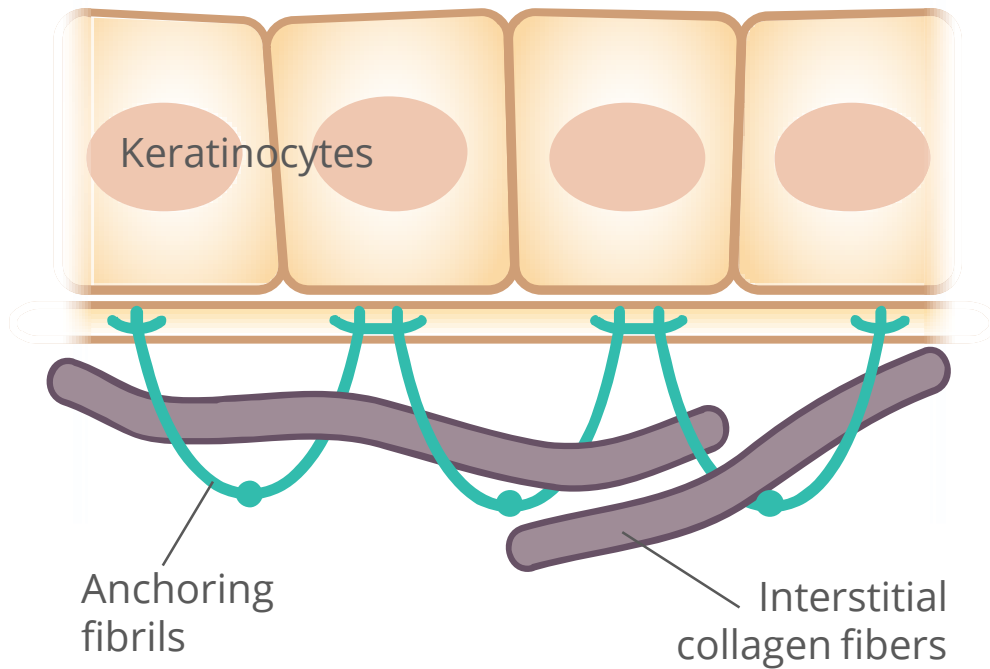


In DEB skin anchoring fibrils are absent or dysfunctional



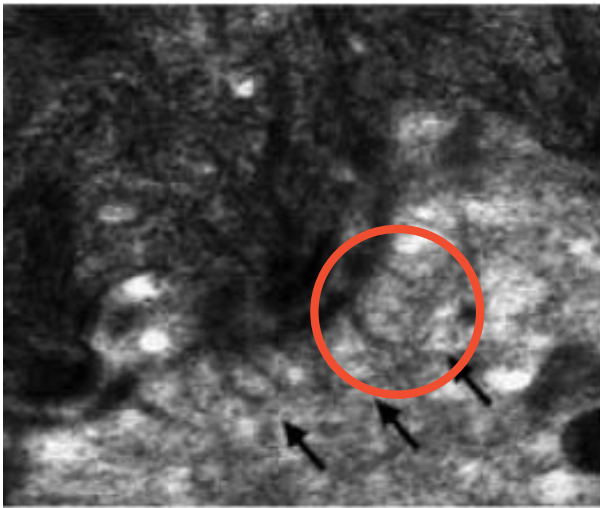
QRX-313 for DEB

Functional Collagen VII Protein

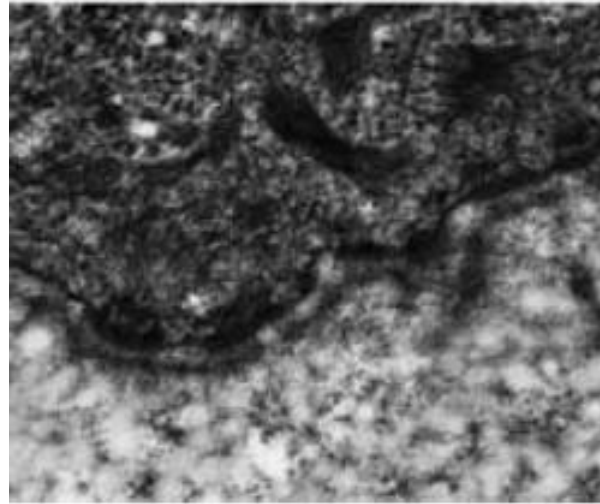


Restoration of anchoring fibrils after exon exclusion

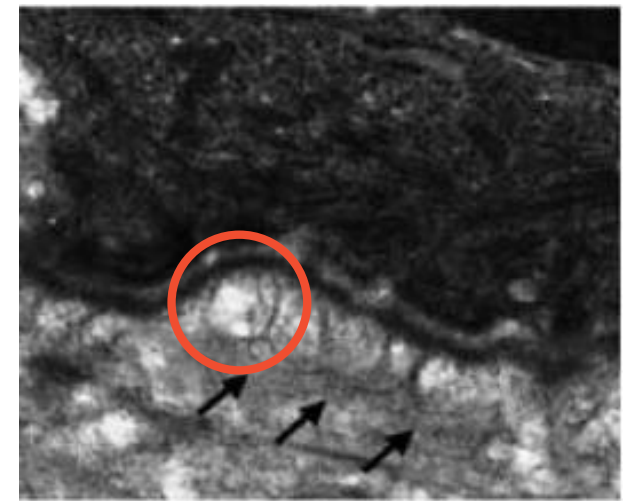
Wild type



Epidermolysis Bullosa



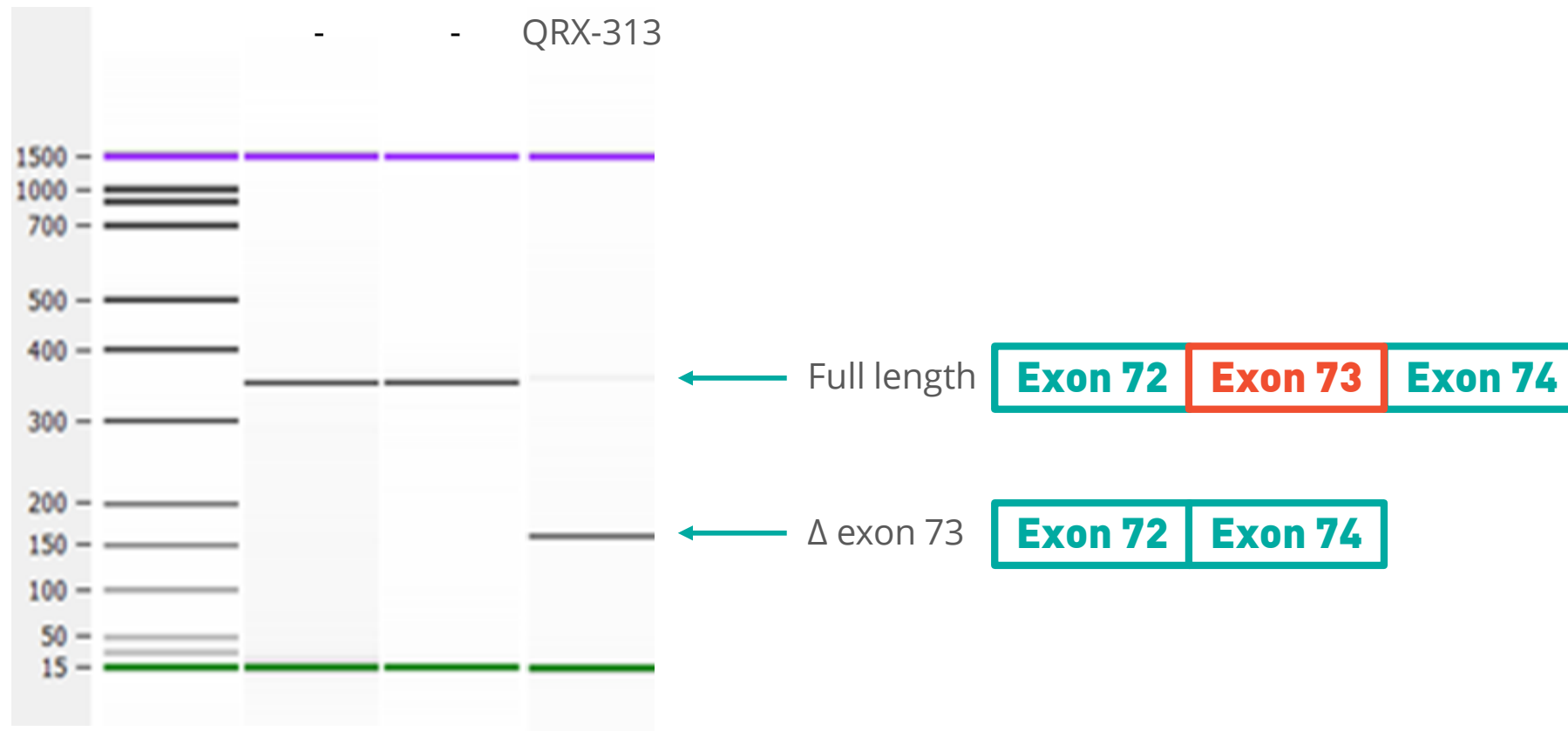
Epidermolysis Bullosa + exon exclusion



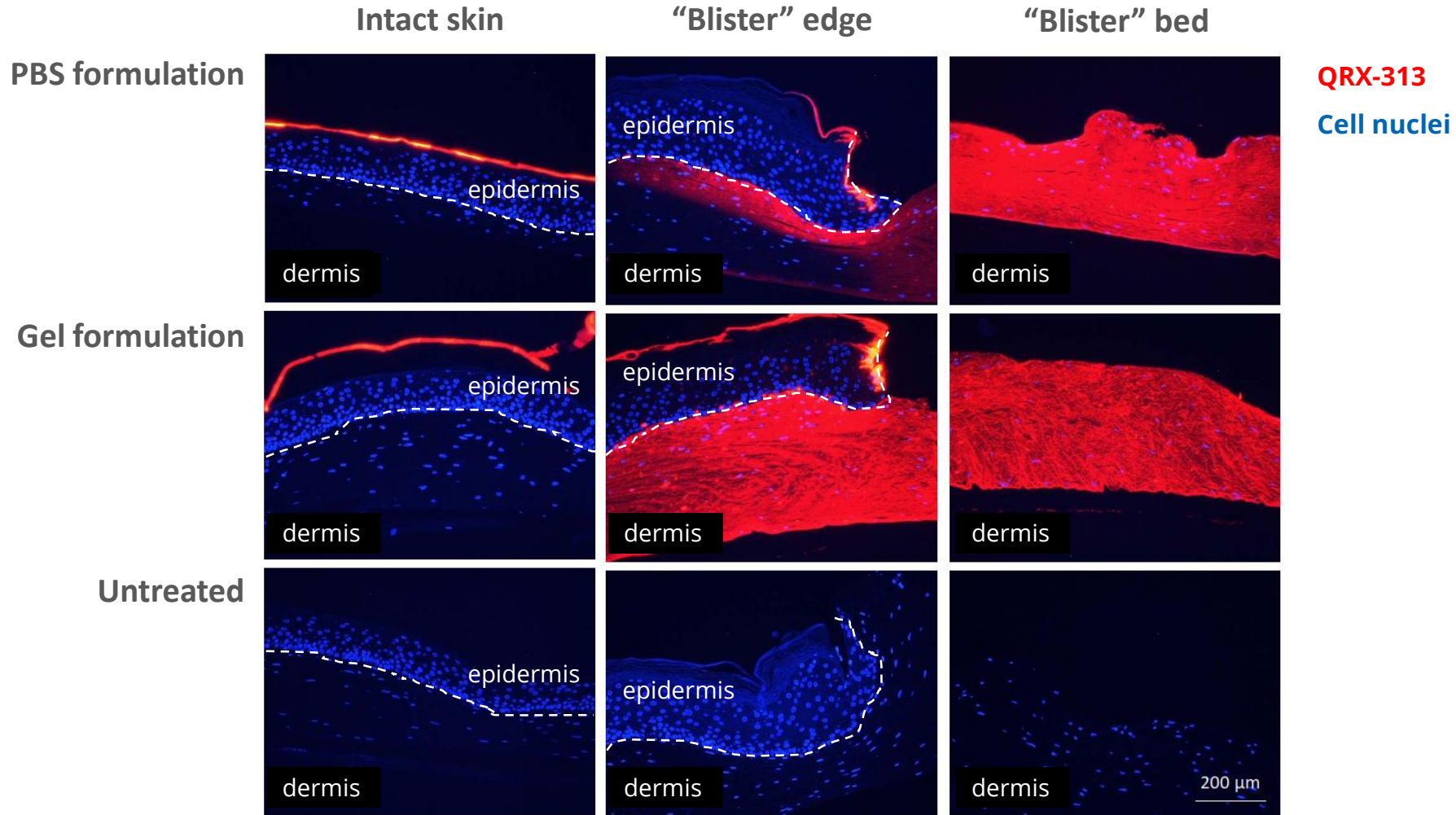
Goto et al, 2006

Exon 73 exclusion with QRX-313

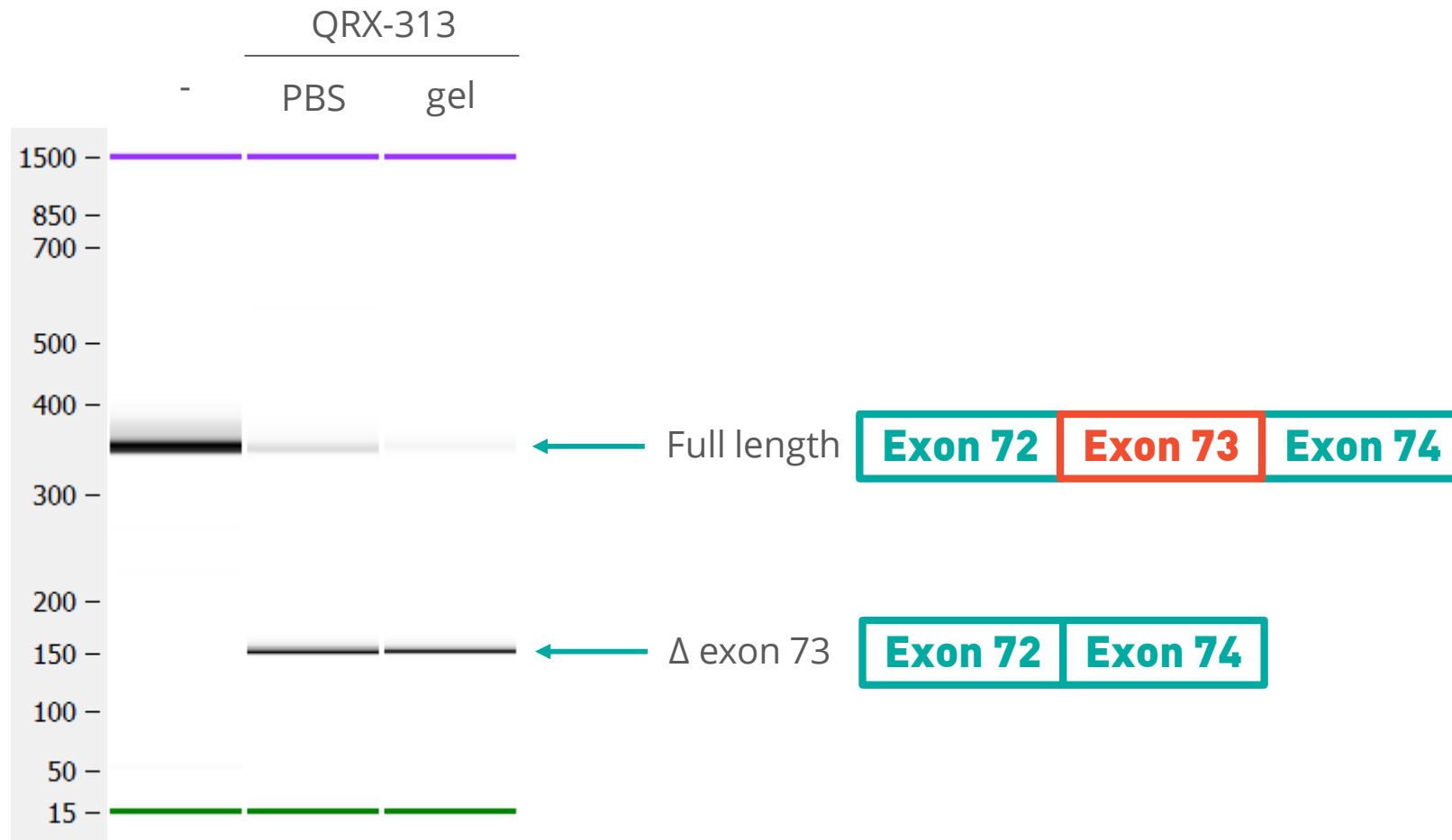
In vitro proof of concept at the RNA level



QRX-313 in formulation penetrates blister-like human skin equivalents



QRX-313 on human skin equivalents induces $\Delta 73$ mRNA in the dermal fibroblasts



QRX-313 status

- ✓ Single stranded oligo nucleotide resulting in removal of mutated exon
 - Well understood mechanism of action
 - Strong pre-clinical PoC
 - Lead compound selected
- ✓ Efficient delivery through topical administration
- ✓ Potential to expand to other subsets of patients



QRX-203

RNA modulation for Alzheimer's disease

QRX-203 for Alzheimer's Disease

Most prevalent form of dementia

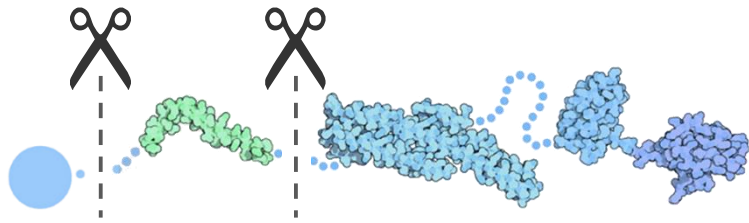
- Progressive neurodegenerative disease
- Impairments of memory, learning ability, language and judgement

Amyloid related disorder

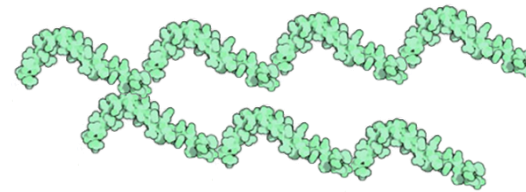
- Toxic amyloid-beta peptide causes plaque formation in brain
- Potential to treat other amyloid-beta related disorders



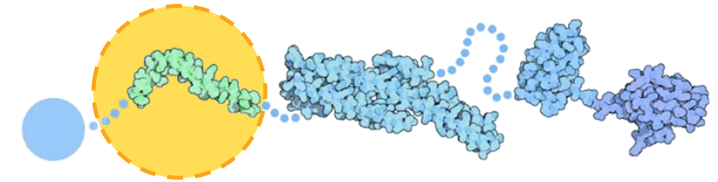
Preventing A β inclusion into mature APP



Enzyme
inhibitors



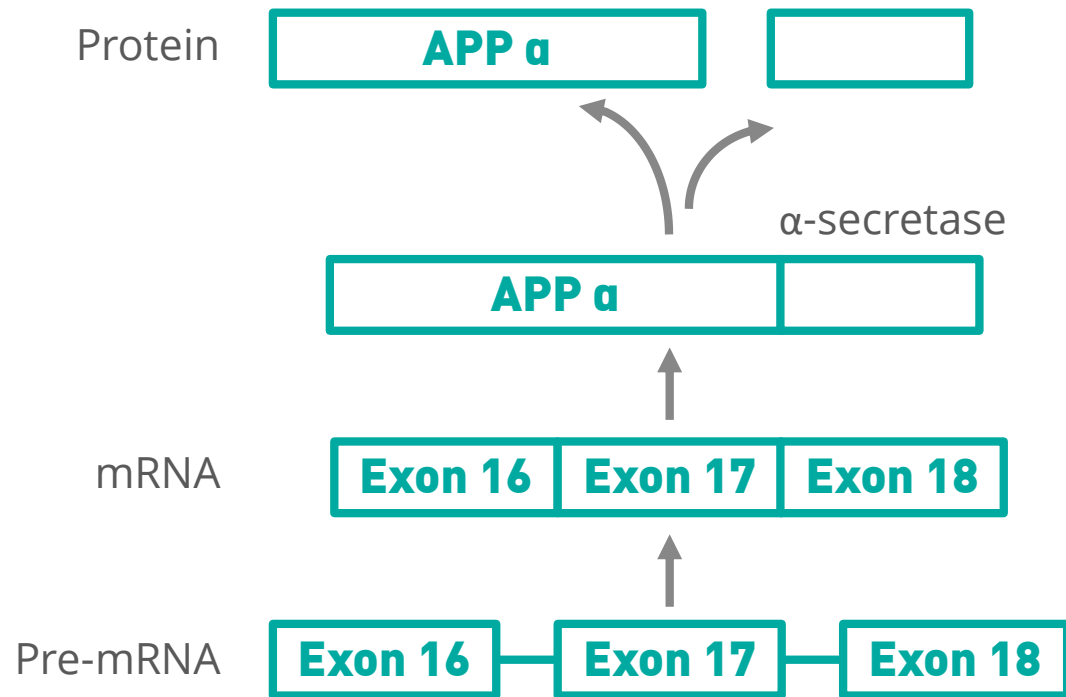
Plaque removing
antibodies



QRX-203

QRX-203 for Alzheimer's disease

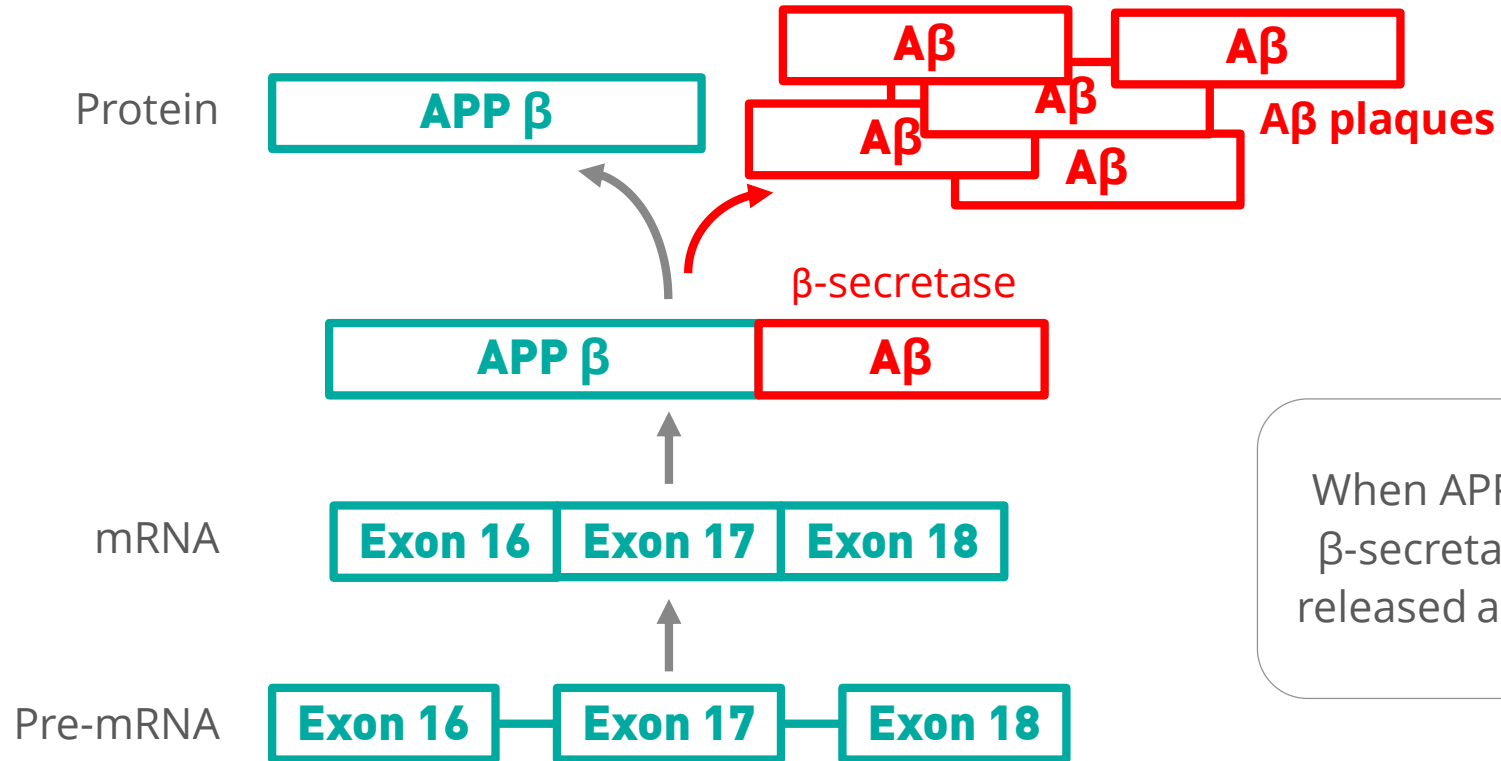
APP processing: Non-Amyloidogenic pathway



The "healthy" cleavage of APP is by α -secretase

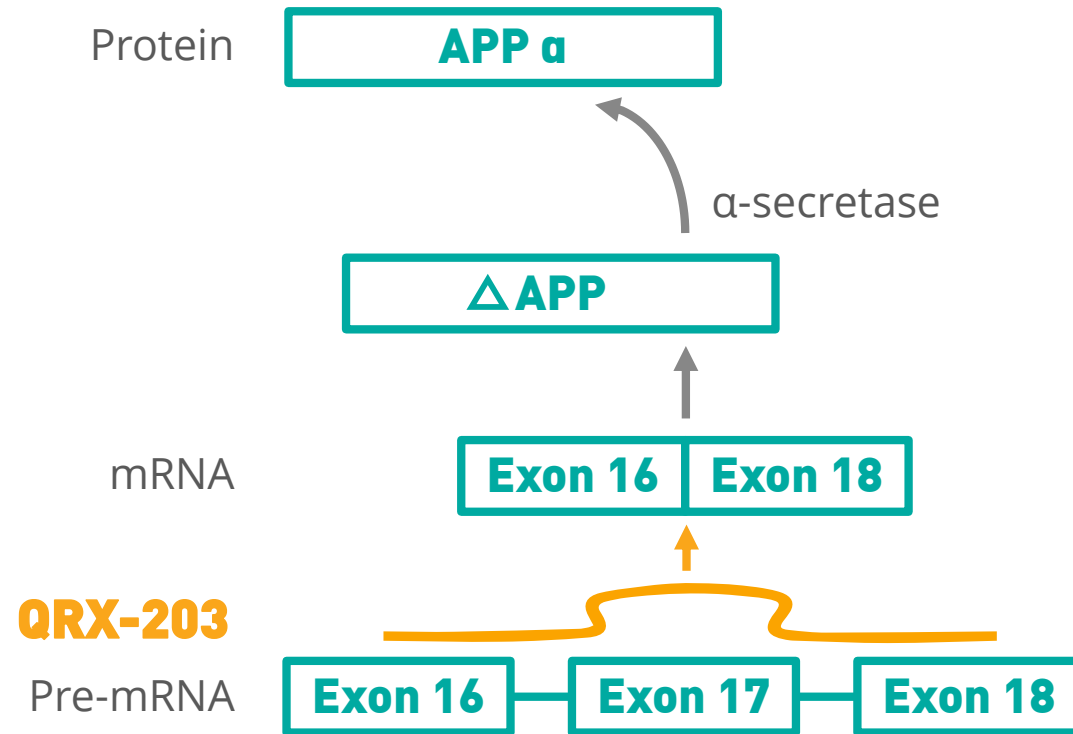
QRX-203 for Alzheimer's disease

APP processing: Amyloidogenic pathway



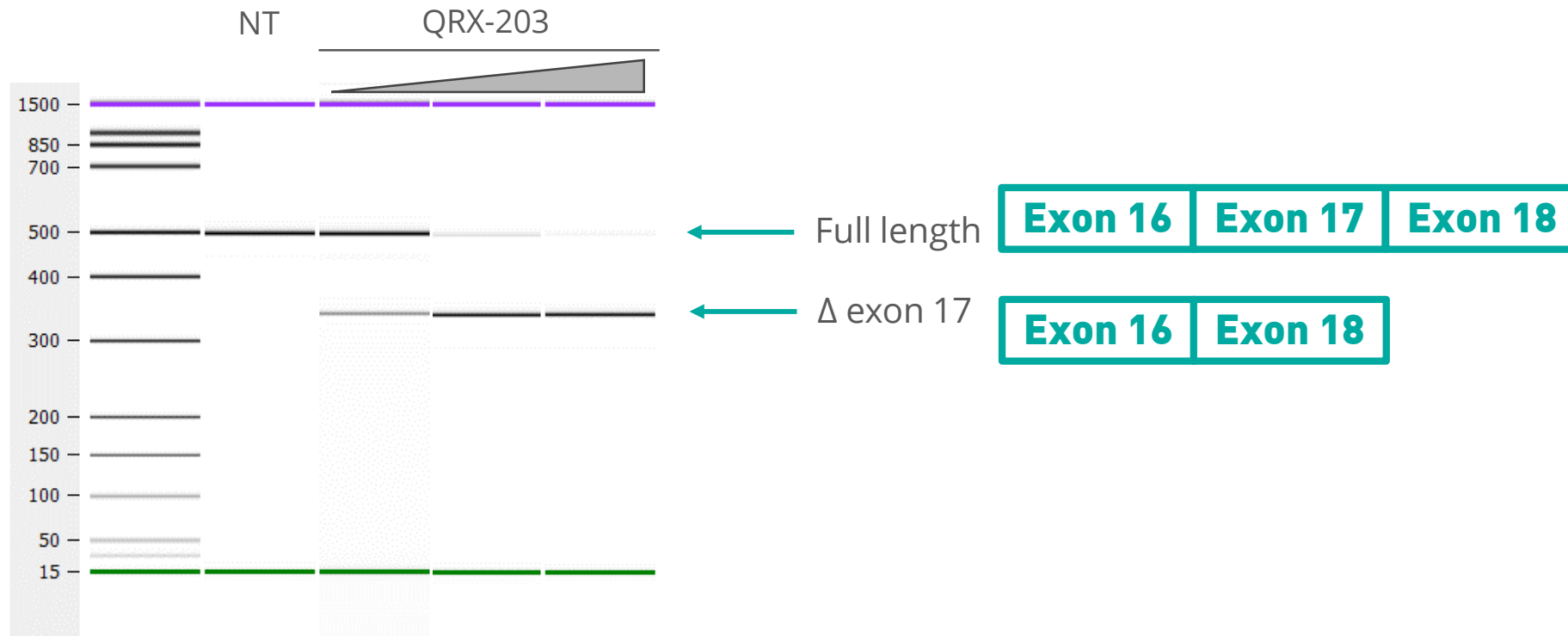
QRX-203 for Alzheimer's disease

Modulates RNA and prevents A β formation



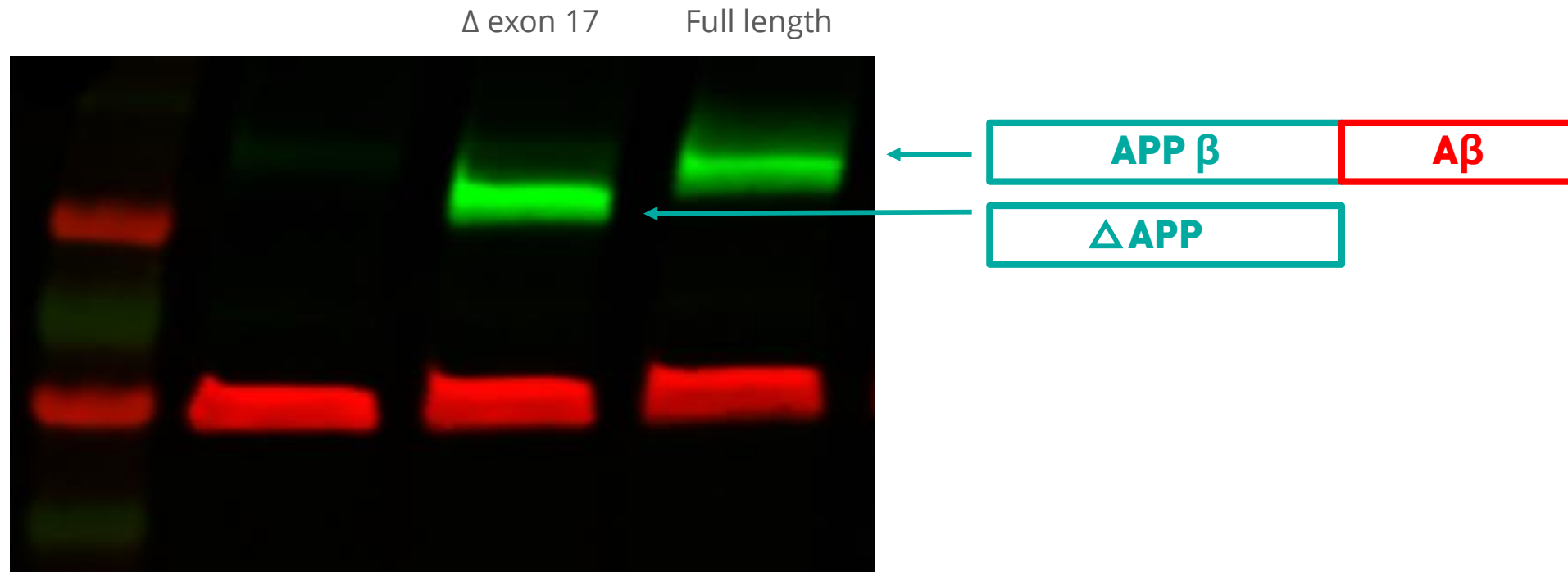
Strong proof of concept

Efficient skip on RNA level



Strong proof of concept

Removal of exon 17 results in protein without A β segment



Validated delivery methods for CNS

Exploring several routes of administration



**Intrathecal
delivery**



**Intranasal
delivery**

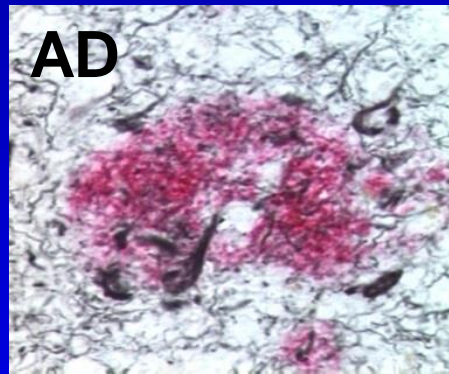


**Intracerebro-
Ventricular
delivery**





Alzheimer's Disease: Disease Pathogenesis, Diagnosis and Treatment Landscape

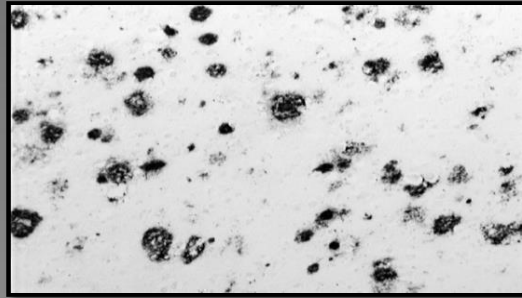


Thomas Wisniewski MD

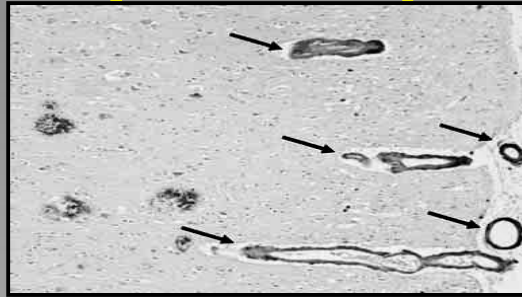
Professor of Neurology, Psychiatry and Pathology

March 14th, 2016

Alzheimer's Disease - most common dementia



Amyloid Plaques



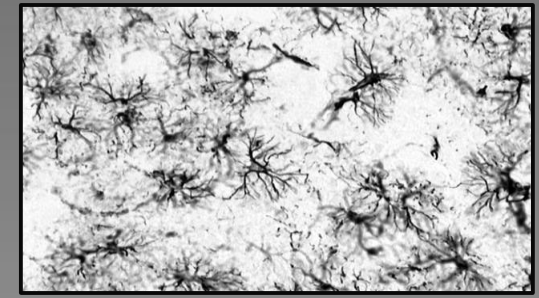
Vascular Amyloid



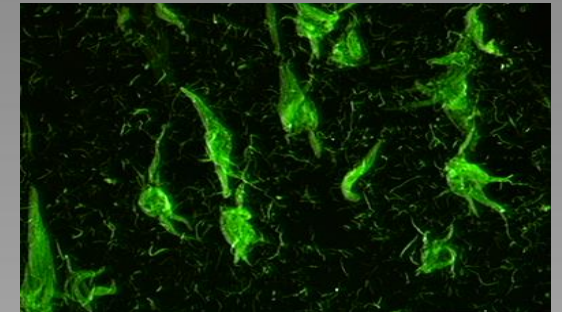
Worldwide

Today: ~47 million

2050: ~131.5 million



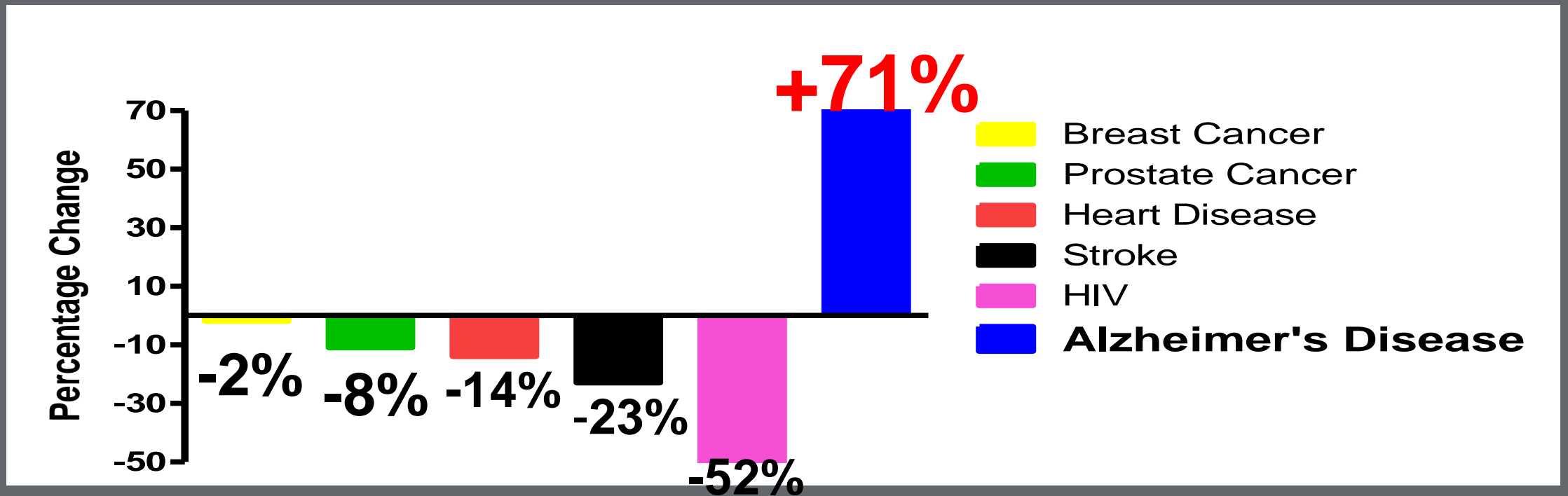
Gliosis



Neurofibrillary Tangles

- Alzheimer's disease is the 6th deadliest disease in the USA
- Only Cause of death among top 10 with no effective treatment(s)
- Affects ~13% of people >65 years old (~1 in 8)
- Affects ~40-50% of people >85 years old
- In 2015 direct costs of AD in the USA are ~\$226 Billion
- Costs will rise to ~1.1 Trillion in 2050, if no treatments are developed

% Change in Deaths between 2000 and 2013



Alzheimer's disease is the only cause of death among the top 10 in the USA without an effective way to prevent, cure or significantly slow its progression!

Costs for Dementia Care in the USA versus Research Funding

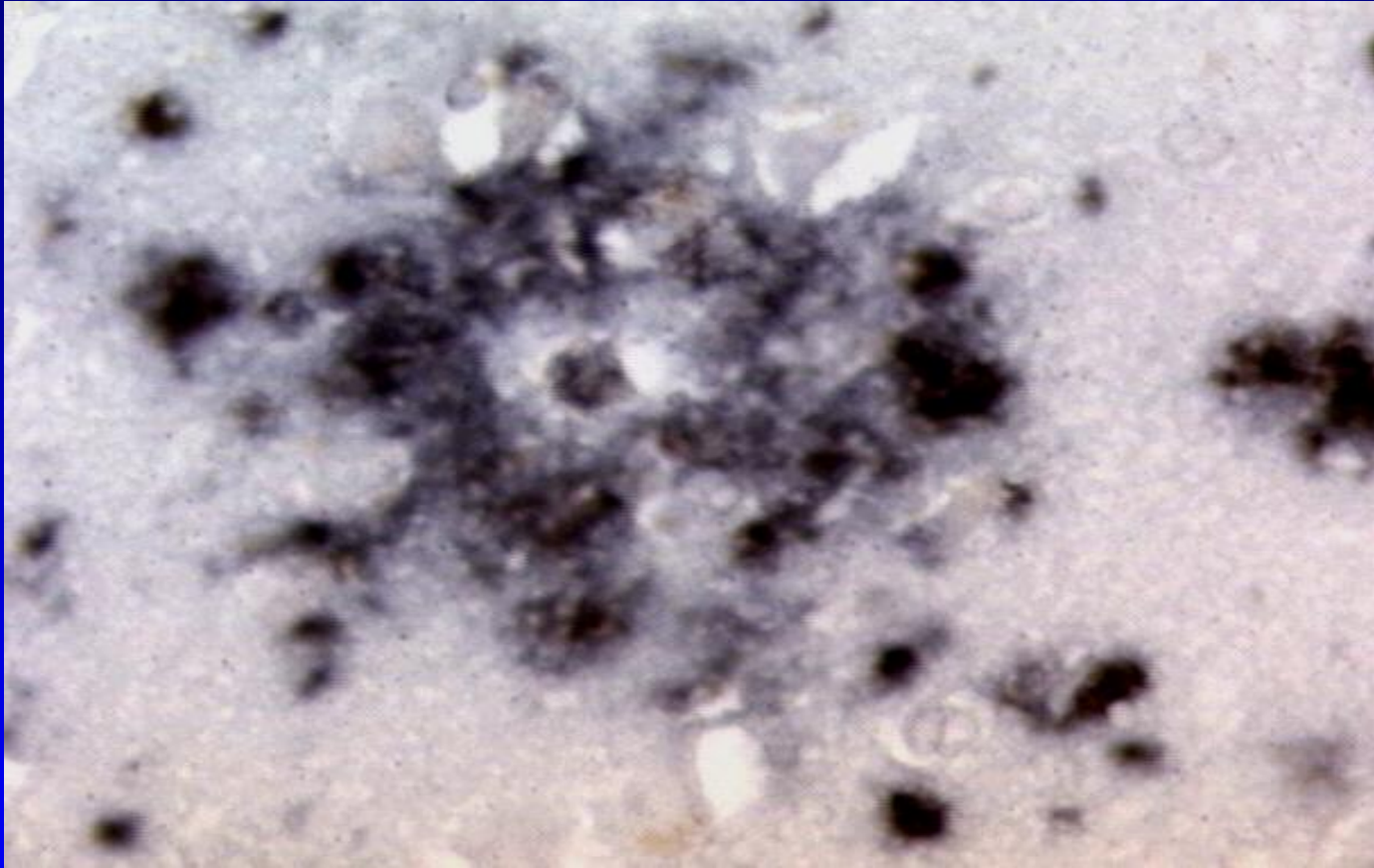
- **Estimates suggest that the monetary costs of care for dementia patients in the USA is significantly greater than all other major medical conditions including cancer and heart disease.***
- **This contrasts with federal research spending: estimated 2015**
Federal Research Spending in 2015:
 - **Cancer: ~5.4 Billion**
 - **HIV/AIDS: ~3 Billion**
 - **Heart Disease: ~2.0 Billion**
 - **Diabetes: ~1 Billion**
 - **Alzheimer's disease: ~586 million**

* Kelley et al. Ann Intern Med 163:729-736, 2015;
Hurd et al. NEJM 368: 1326-34, 2013

Neuropathology of Alzheimer's Disease

- **Neuritic Plaques**
- **Neurofibrillary Tangles**
- **Congophilic Angiopathy**
- **Synaptic Loss**

Alzheimer's Pathology

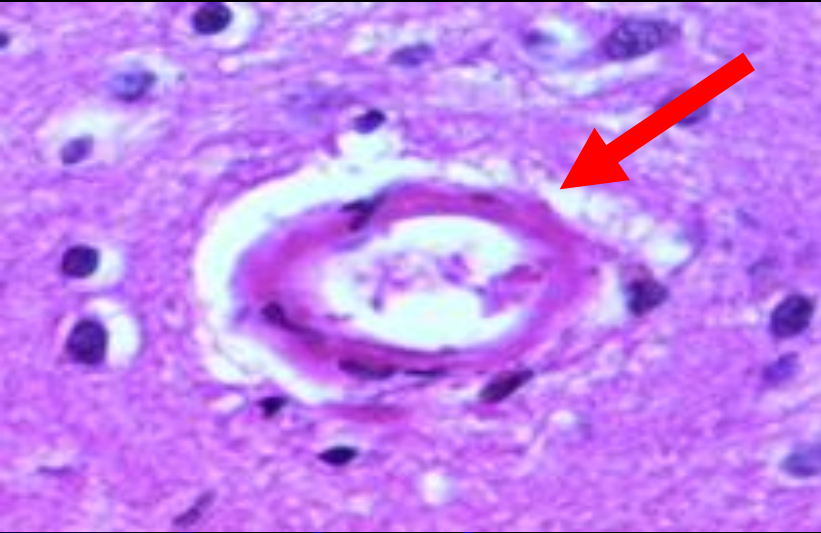


Amyloid plaque shown by
Immunohistochemical labeling
With anti-amyloid β antibody

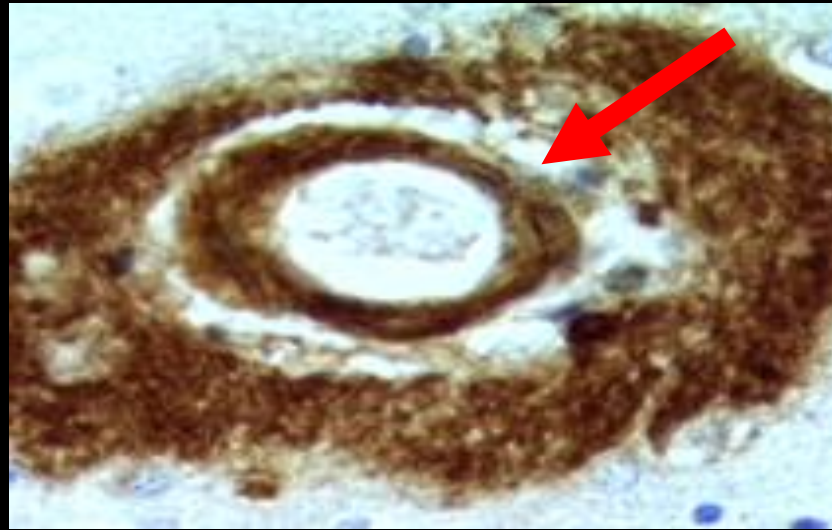


Neurofibrillary Tangle shown
By immunofluorescent labeling with
Anti-phosphorylated tau antibody

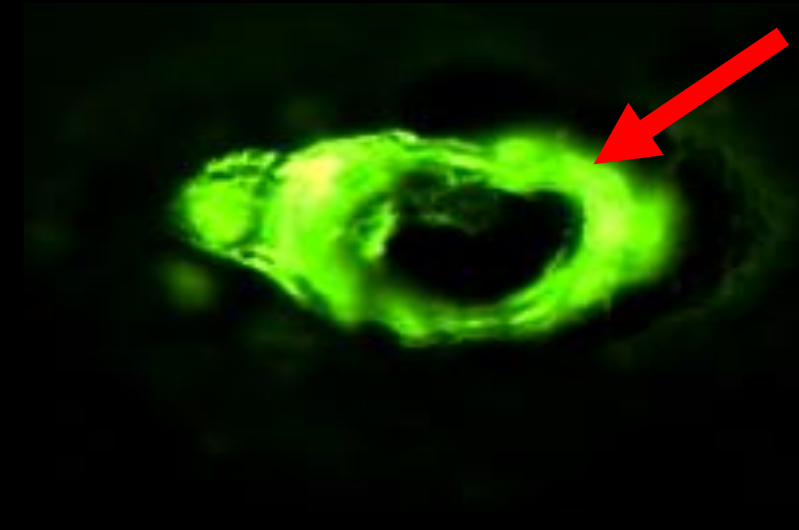
Congophilic Angiopathy



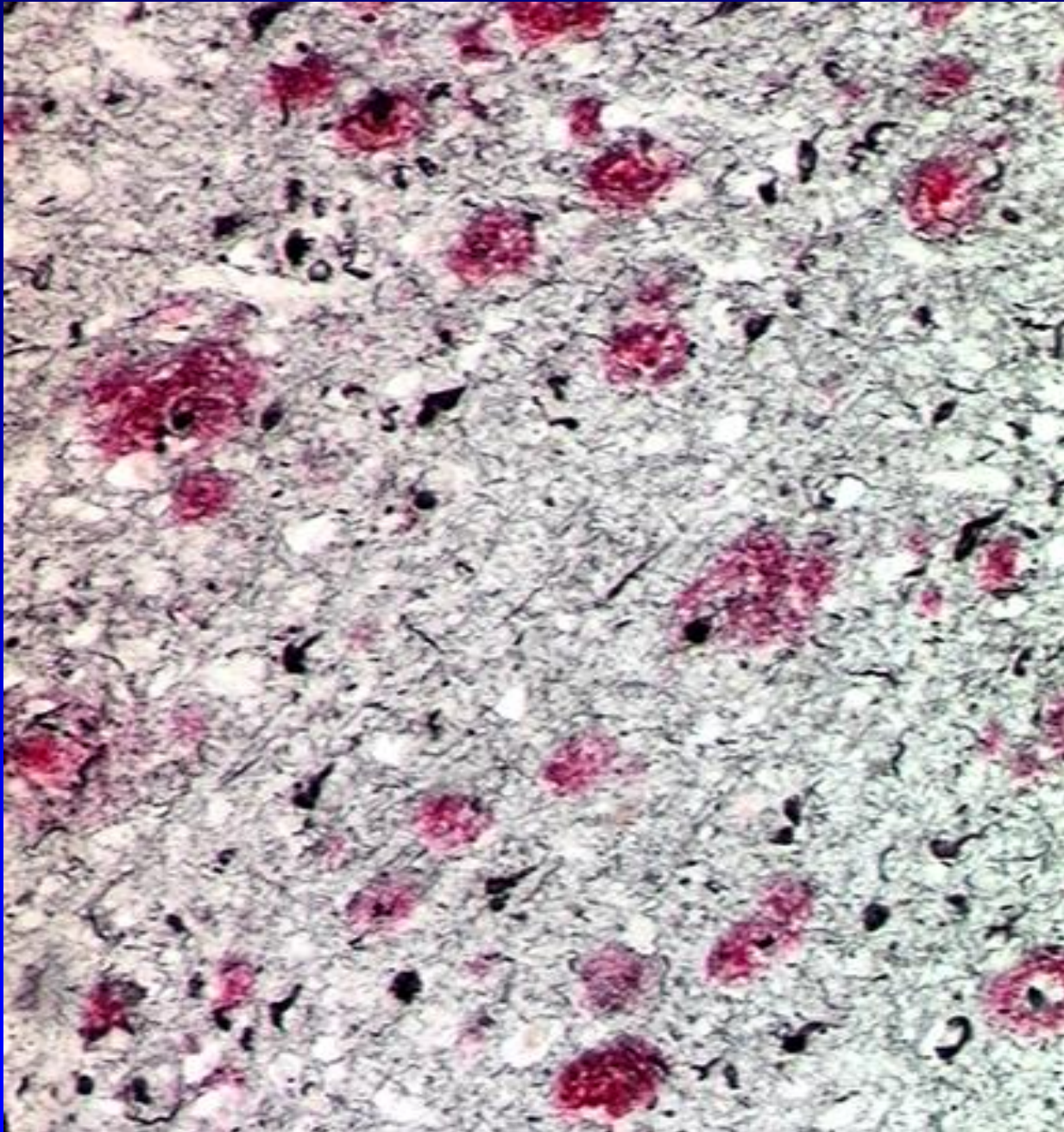
H & E Stain



A β Immunoreactivity

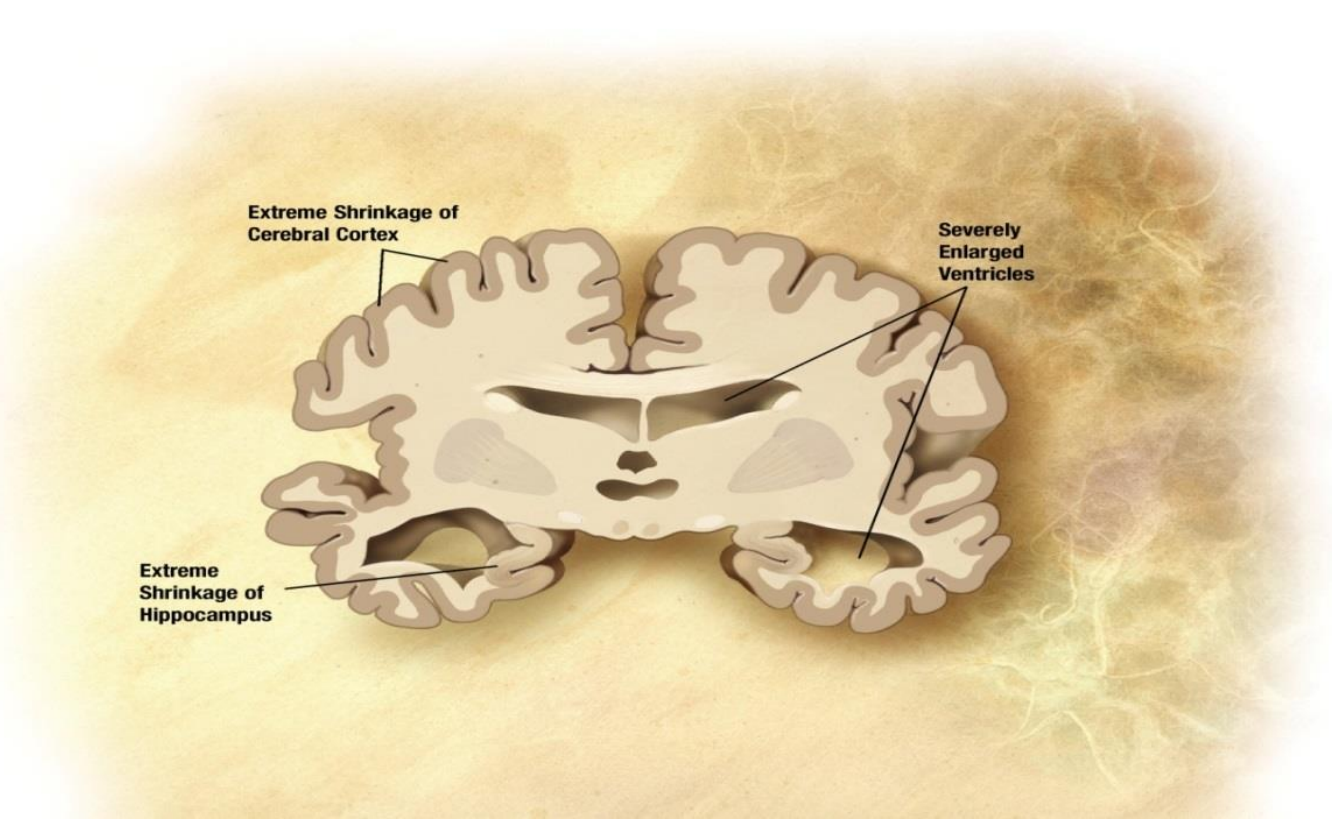
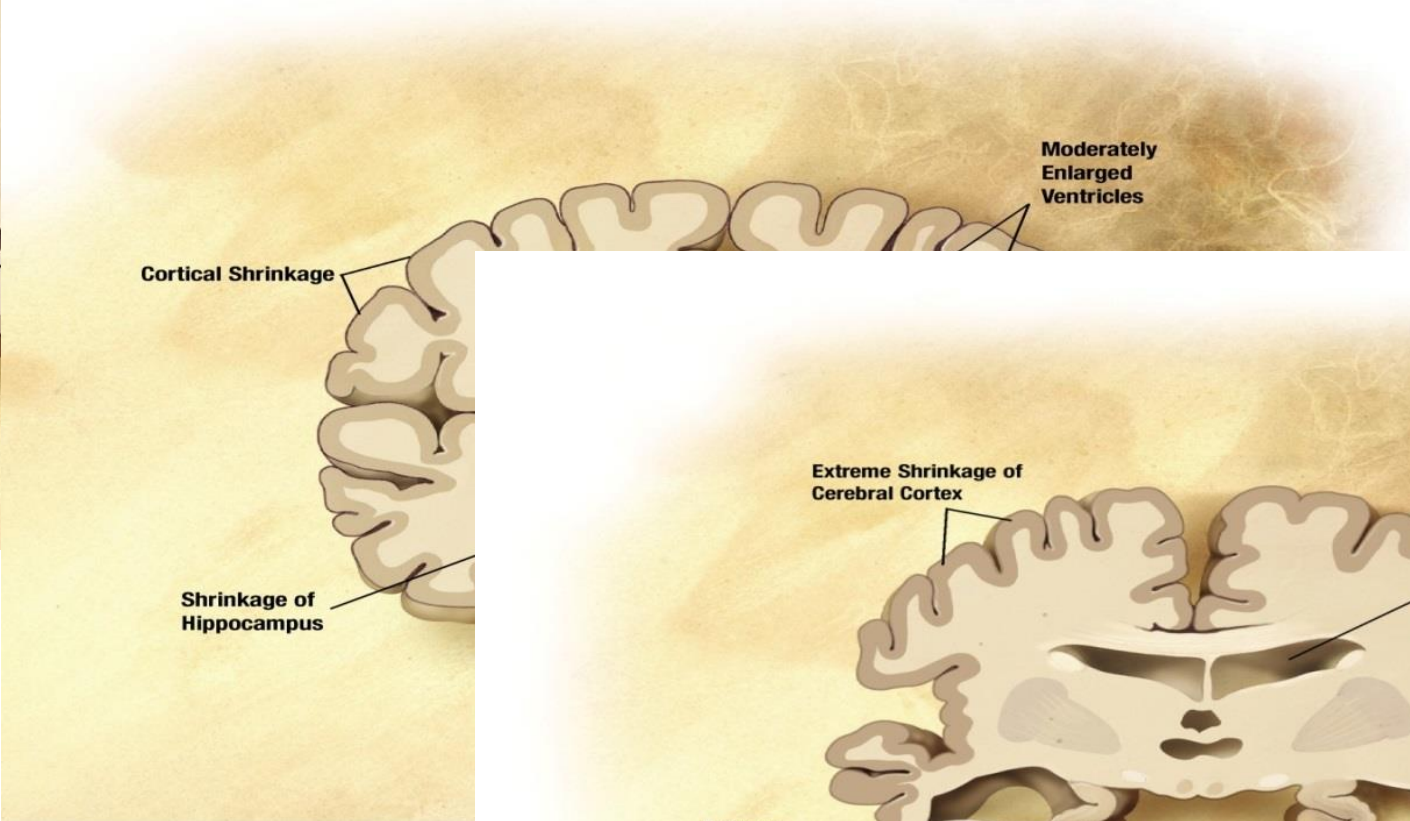


**Congo Red Staining
under polarized
light**

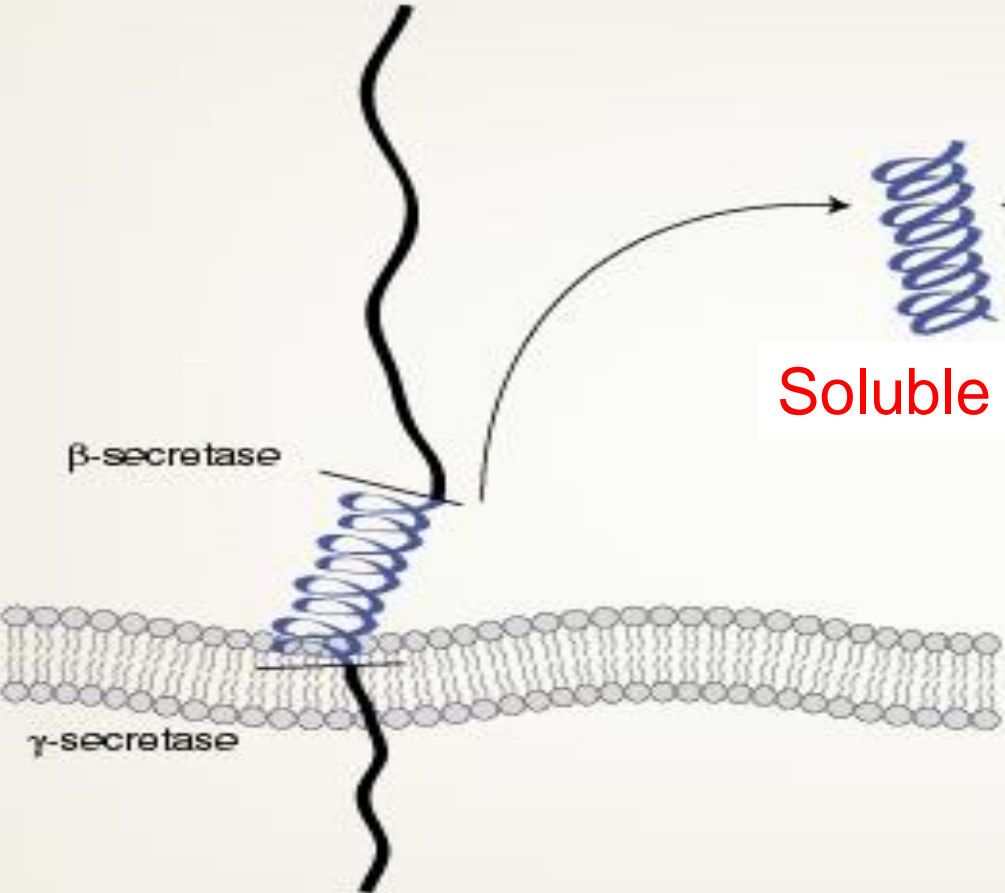


**A β immunostaining in
Neuritic Plaques in Red**

**Abnormally phosphorylated tau
(PHF1) Immunostaining in
Neurofibrillary Tangles
And Dystrophic Neurites
in Black**



Amyloid Cascade Hypothesis of Alzheimer's Disease

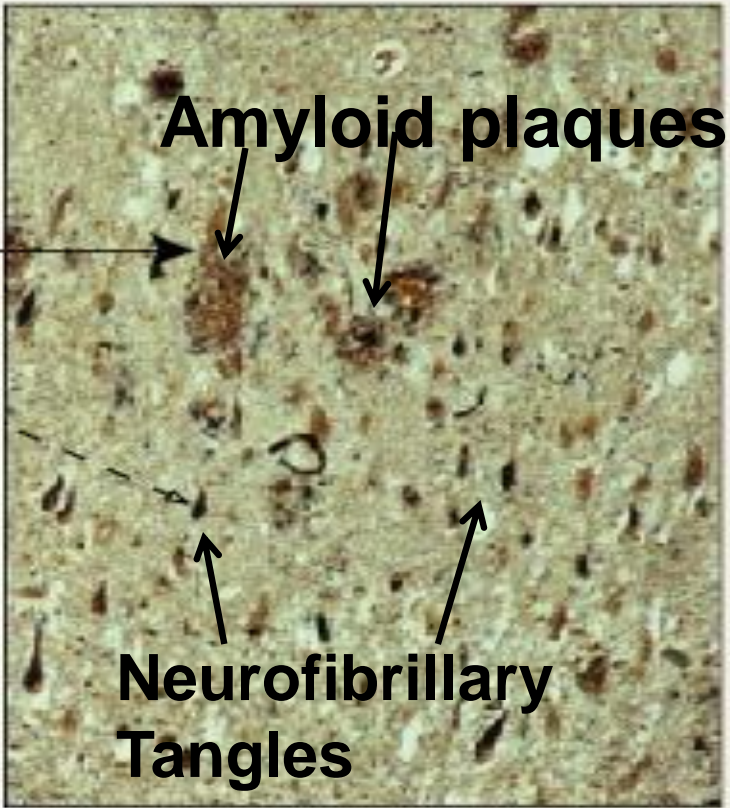


(A) Amyloid precursor protein

Soluble Aβ

Oligomer Aβ

Most Toxic Species of Aβ



Formation of amyloid deposits and subsequent neurofibrillary tangles.

Accumulation of toxic oligomeric Aβ species is driven by either over production or impaired clearance.

Alzheimer's disease

Familial

Onset <60y

~1%

Inherited abnormalities of:

- presenilin 1 (PS 1)
- presenilin 2 (PS2)
- amyloid precursor protein (APP)

Sporadic

Onset >65y

~99%

Risk factors increasing likelihood of Alzheimer's

Environmental

Age

Head trauma

High blood pressure

High cholesterol

Diabetes

Stroke

Inherited

Apo E isoform

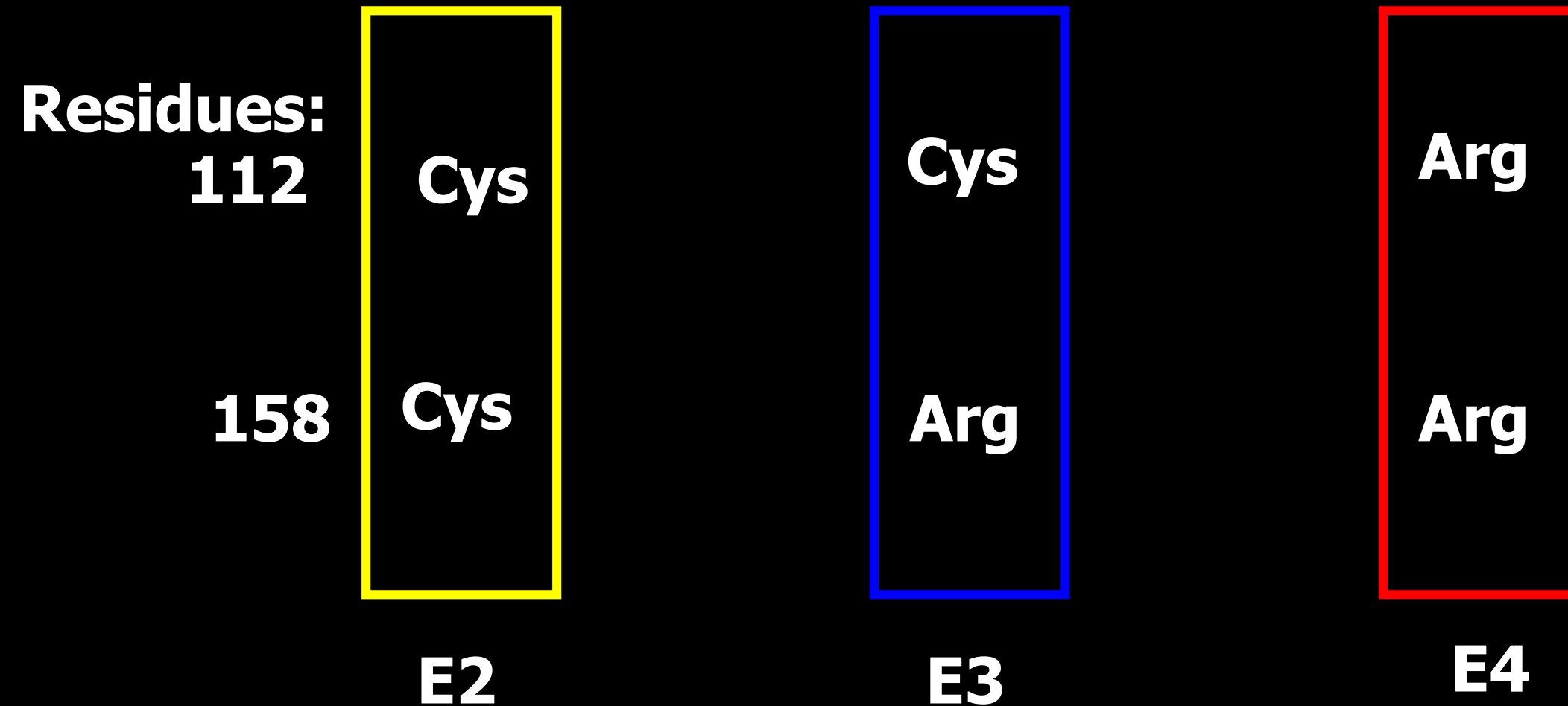
First degree

Relative

~20 GWAS identified

Genetic risk factors

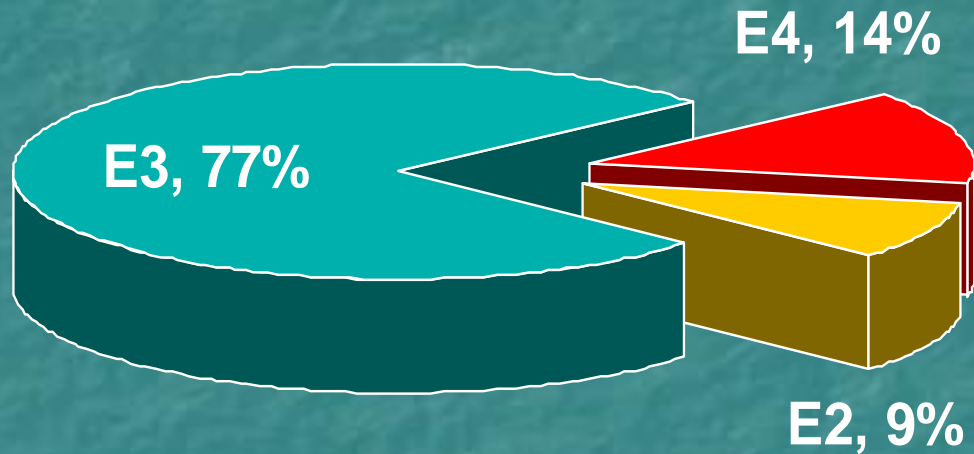
Apolipoprotein E Isoforms



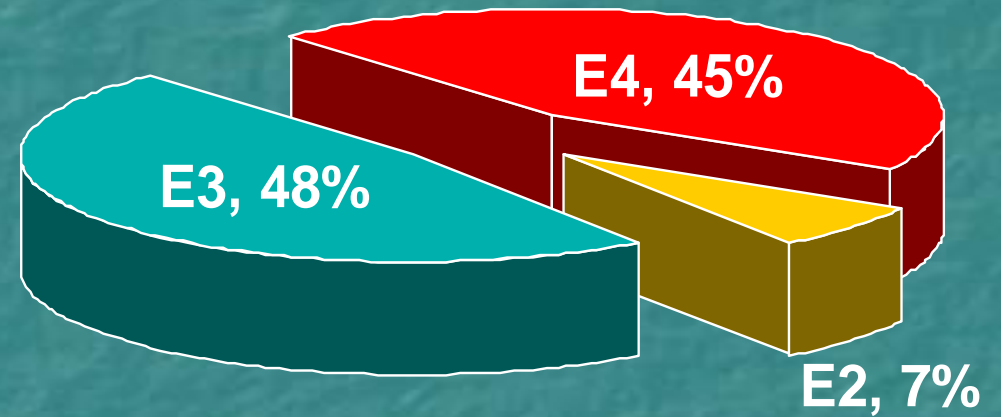
Apolipoprotein E isoform profile is the strongest risk factor for sporadic AD.

Apolipoprotein E isoform frequency

General population



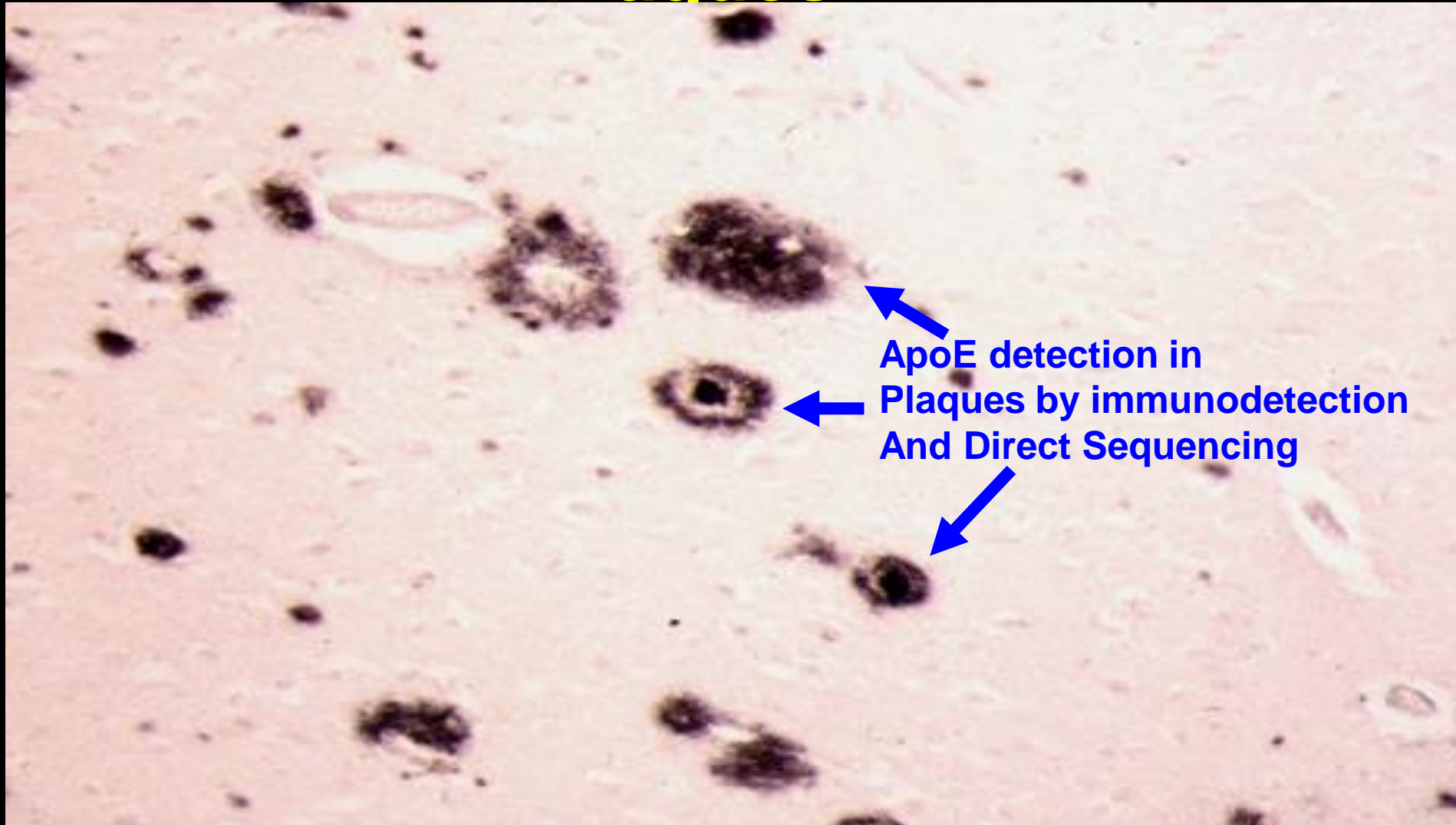
Sporadic AD population



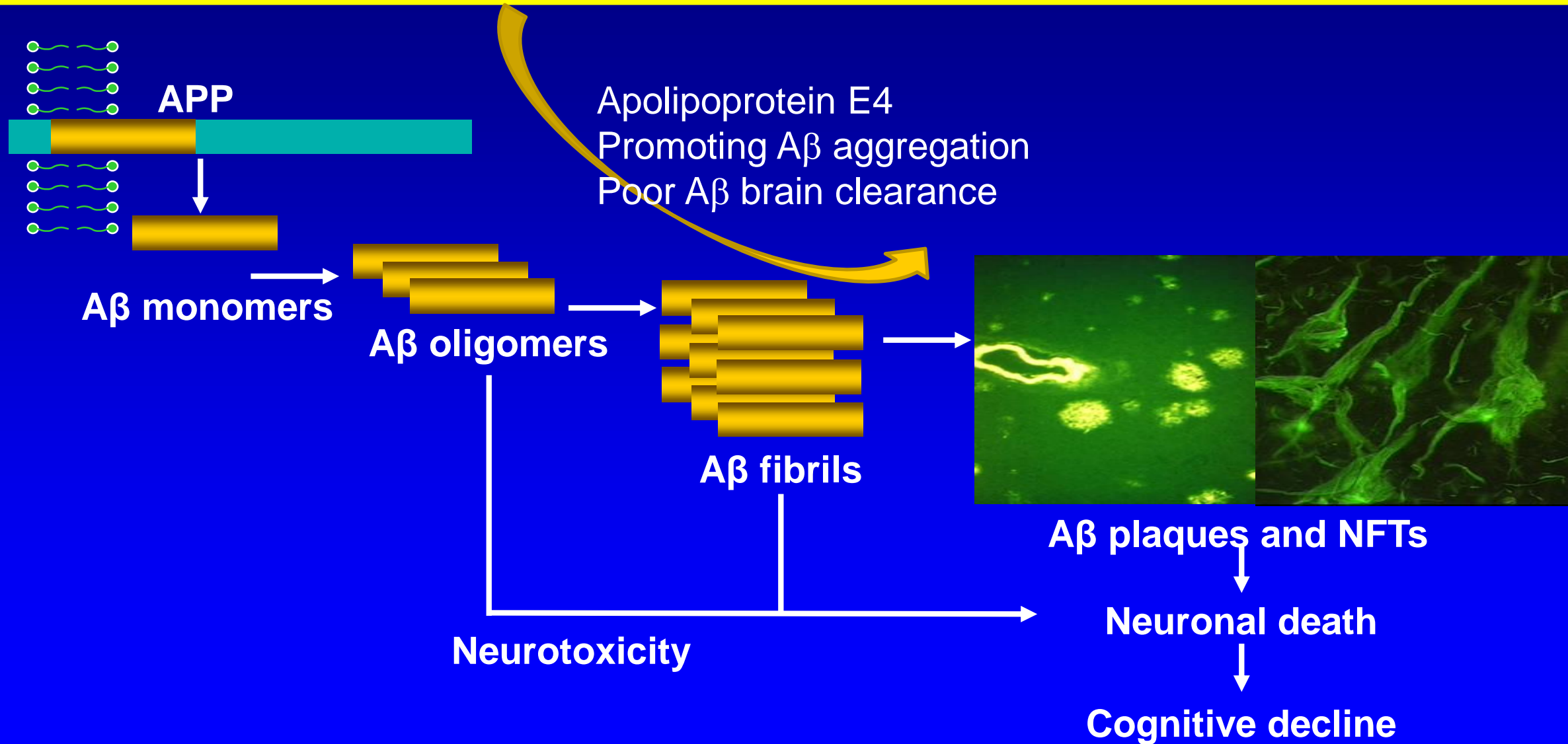
E4/E3 or **E2**- 2-3 fold increased risk

E4/E4 8-10 fold increased risk

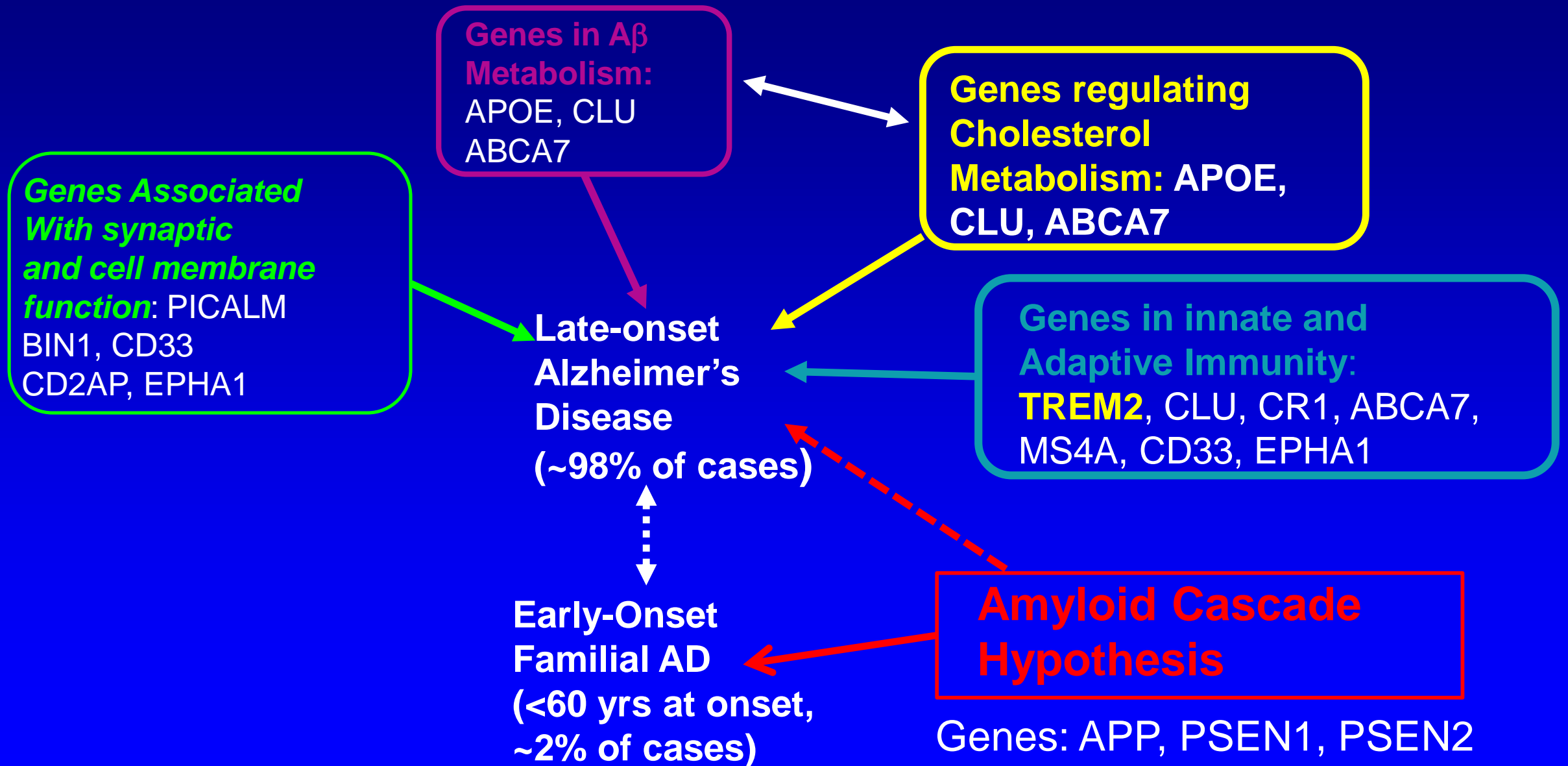
Apolipoprotein E Co-Localizes with A β in Plaques



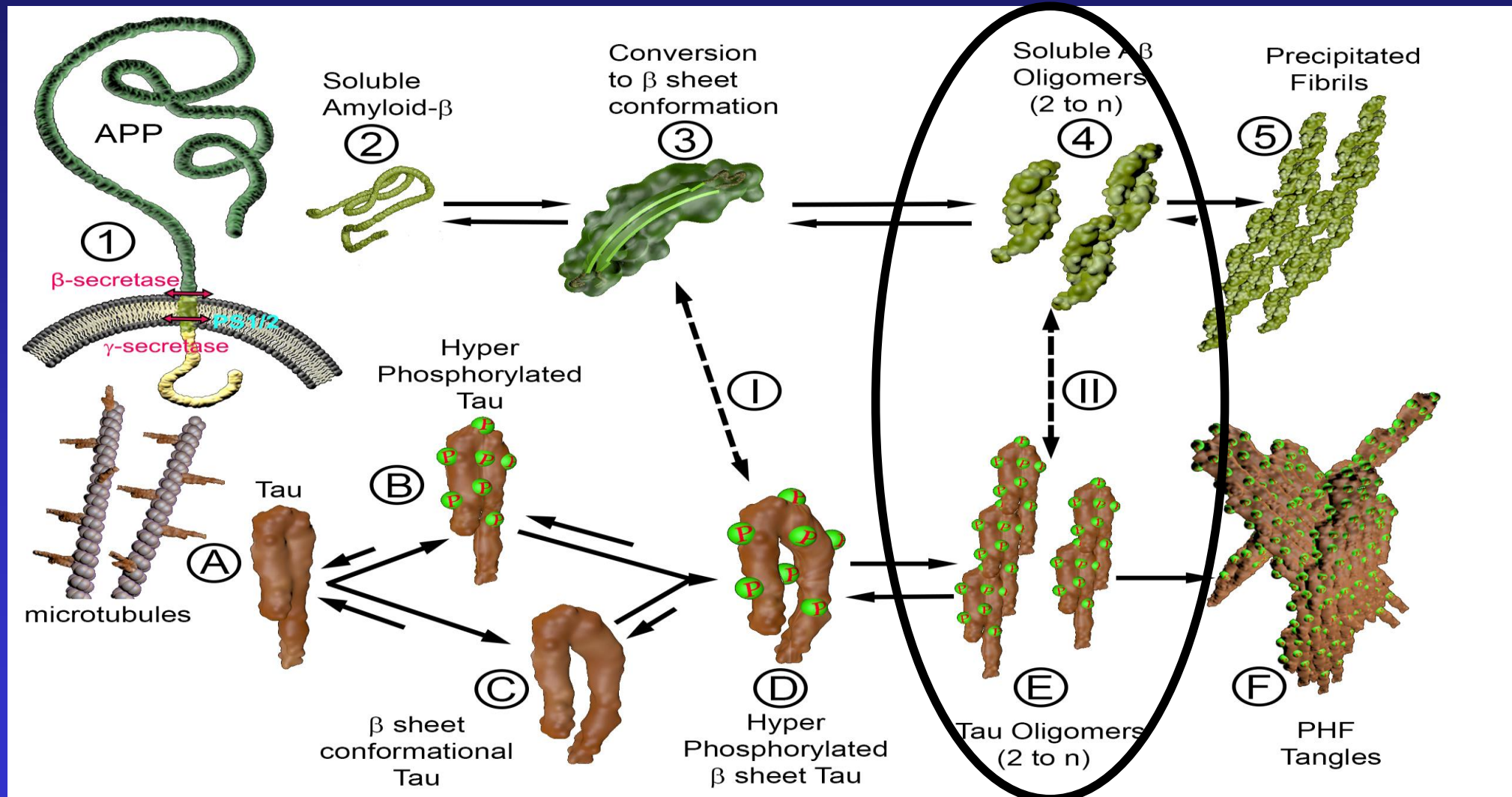
The Amyloid (A β) Cascade



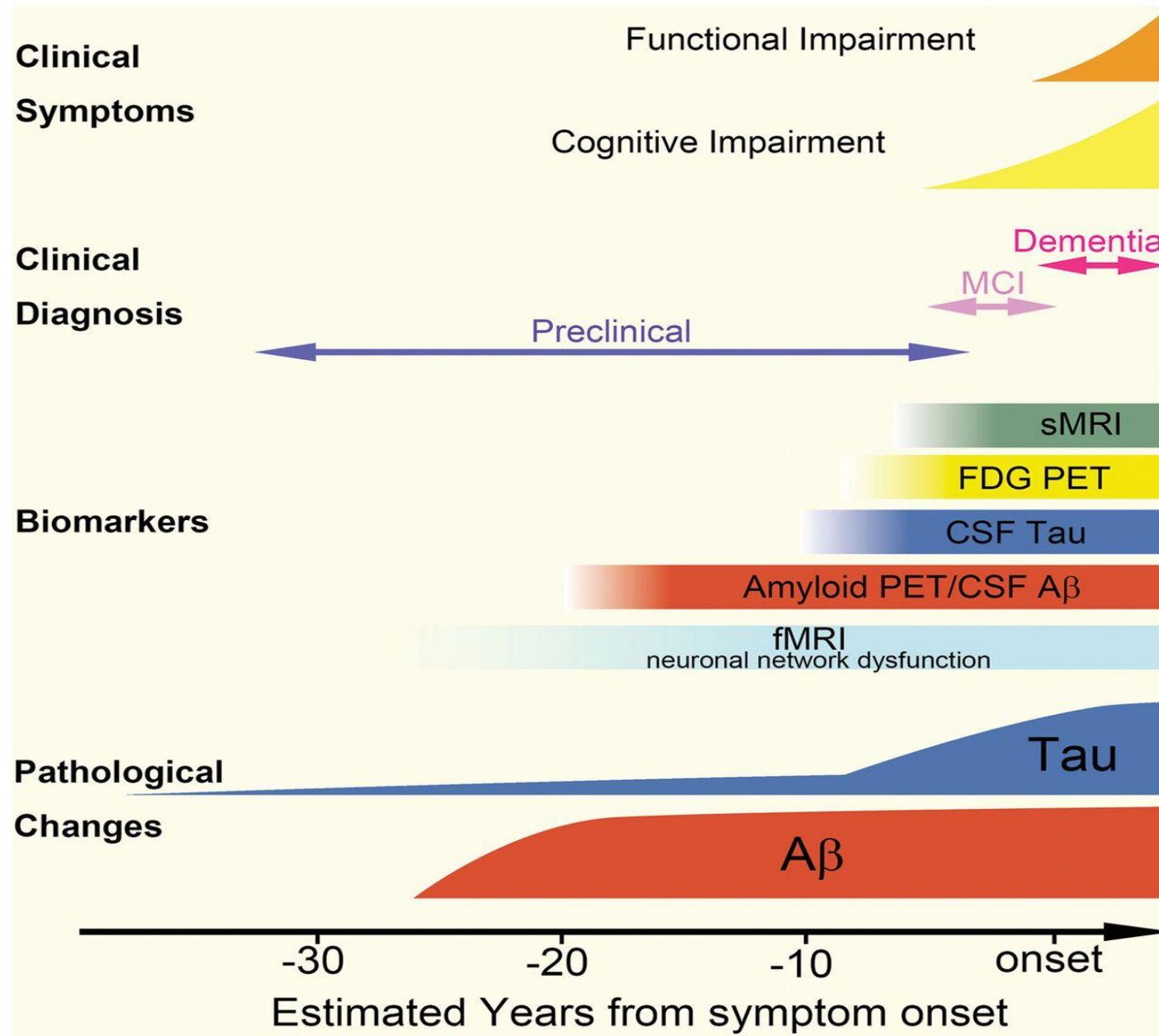
What Recent Gene Wide Association Studies (GWAS) Tell Us about the Cause(s) of Late-onset Alzheimer's Disease



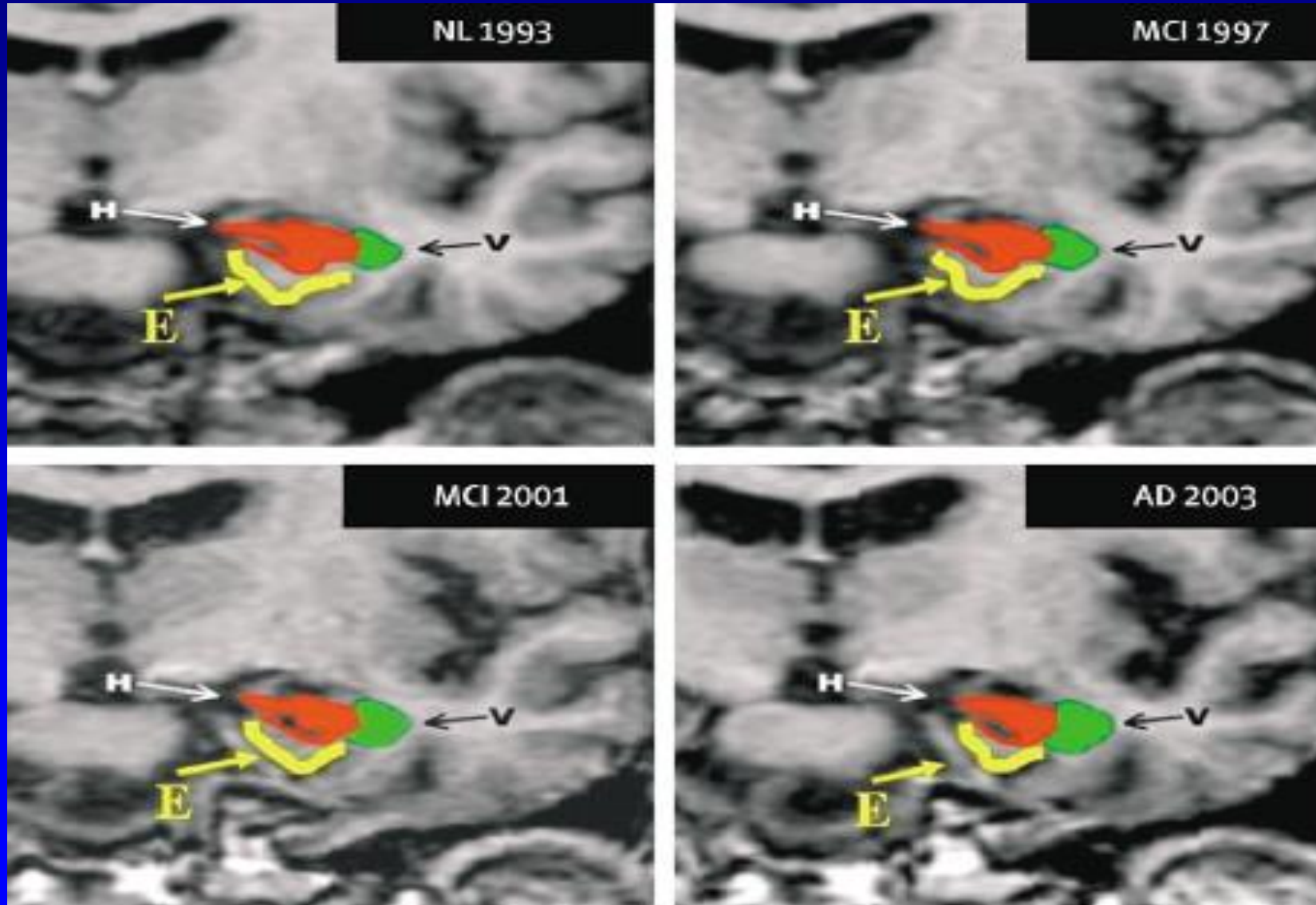
A β and Tau Conformational Changes in AD



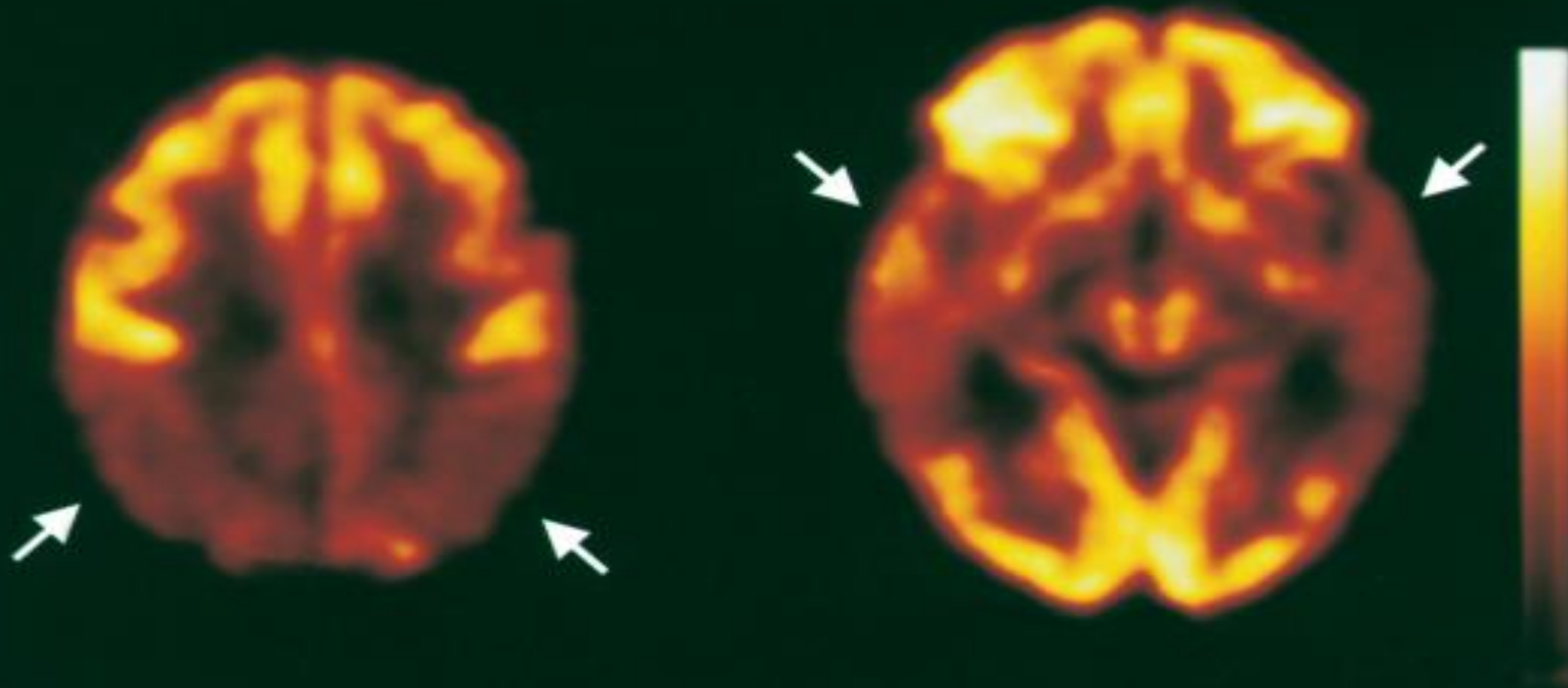
Chronological relationships among pathology, clinical symptoms and biomarkers



Hippocampal/Entorhinal Cortex Atrophy in MCI/AD

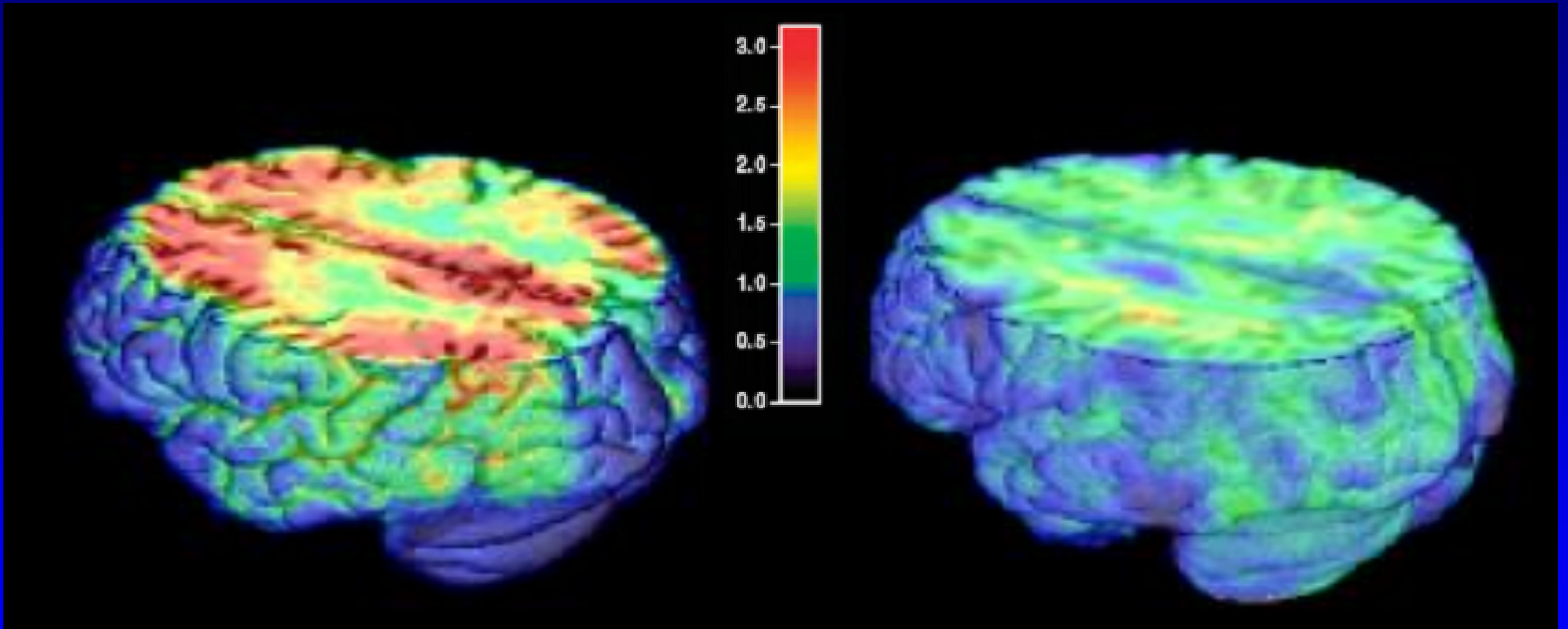


FDG-PET in AD



**Characteristic
Biparietal and
Bitemporal
Hypometabolism
With sparing
Of sensorimotor
cortex**

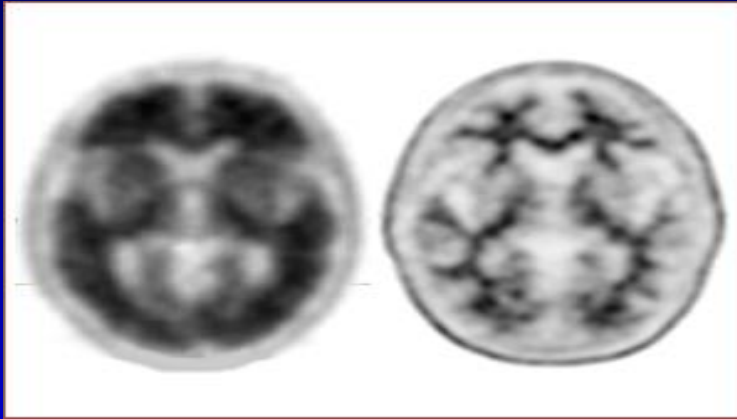
PIB *in vivo* Amyloid Imaging



**Alzheimer's Disease Patient
Showing extensive amyloid binding
(In red)**

**Control Age Matched Patient with
No amyloid binding**

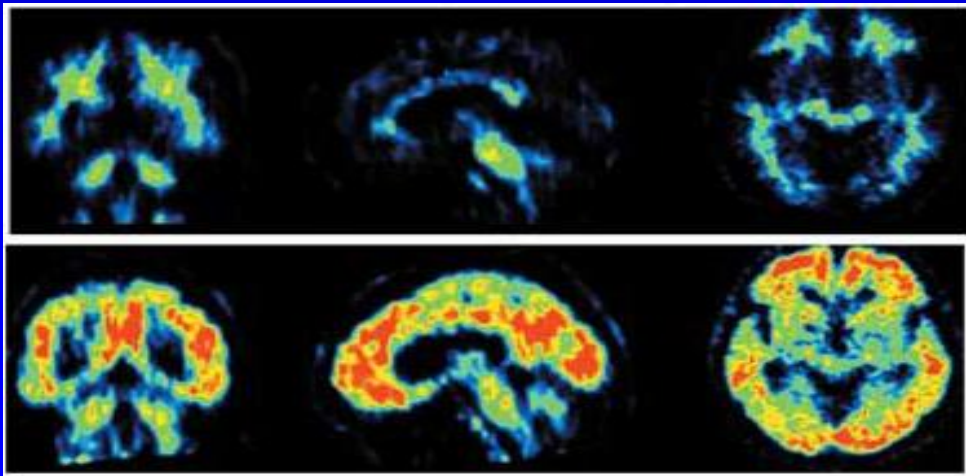
Florbetapir (Amyvid) for Direct Amyloid Imaging



+ve amyloid uptake

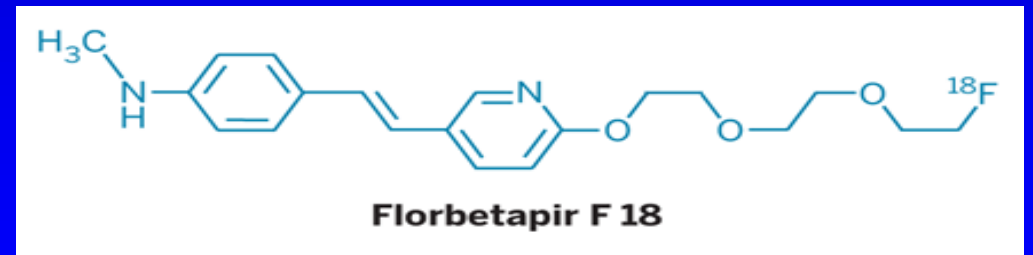
negative scan

florbetapir was approved by the FDA as a diagnostic imaging agent on April 9th, 2012



Control

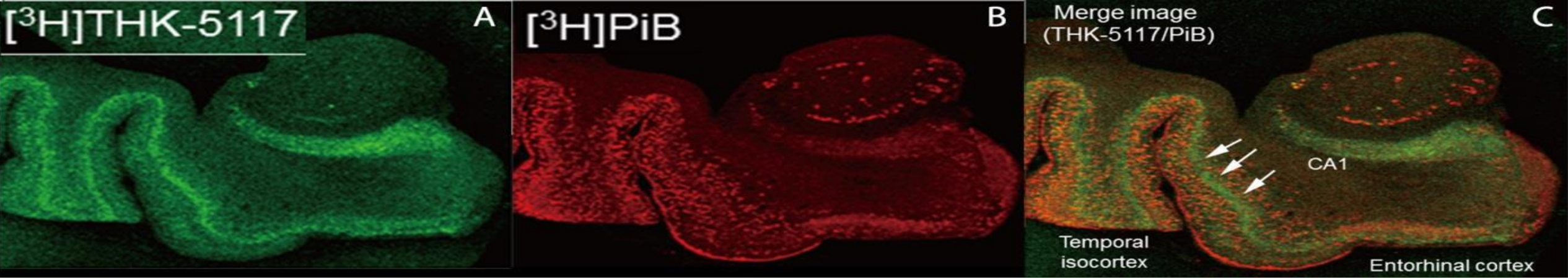
AD Patient



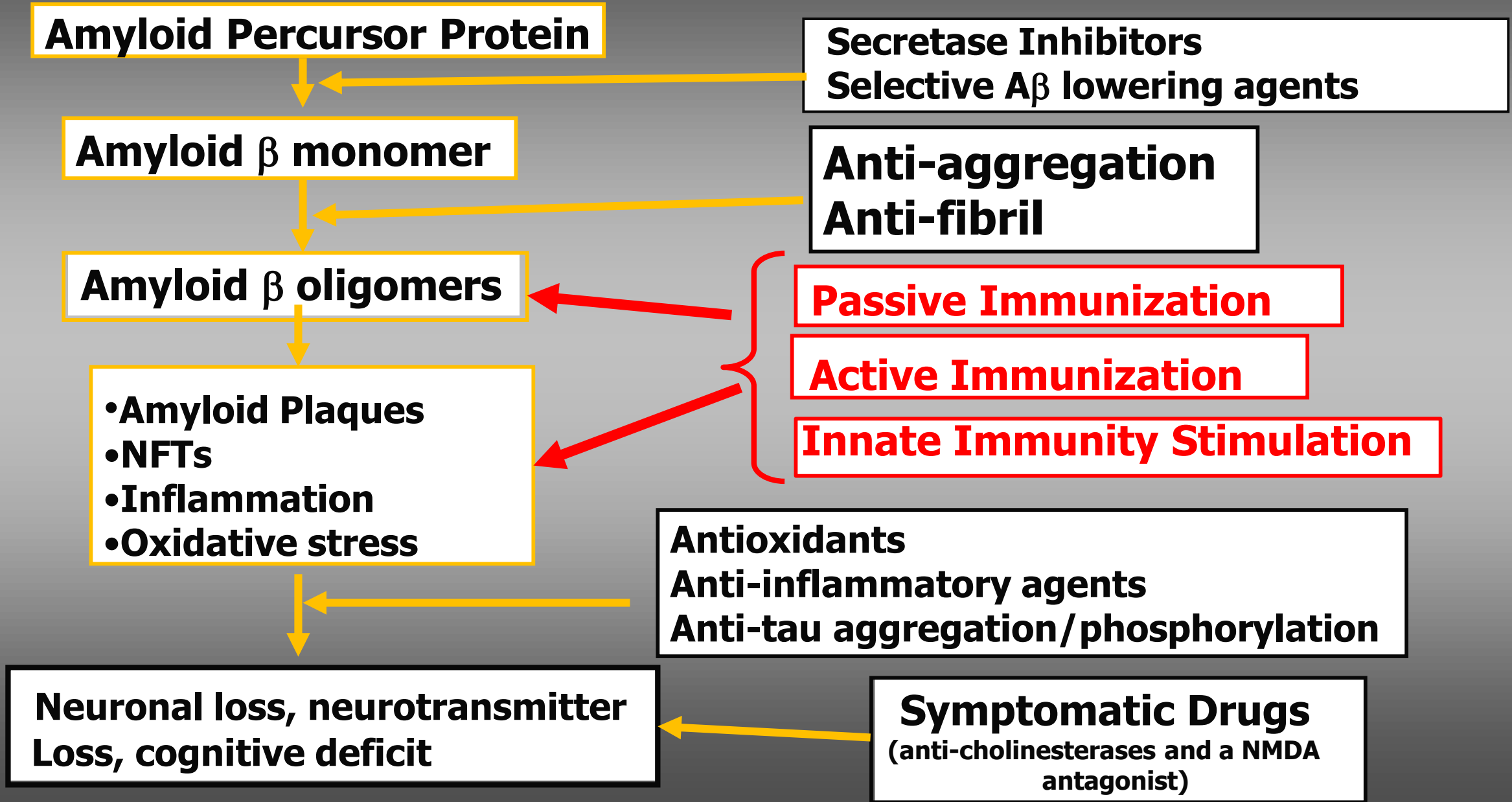
PET AMYLOID AND TAU TRACERS



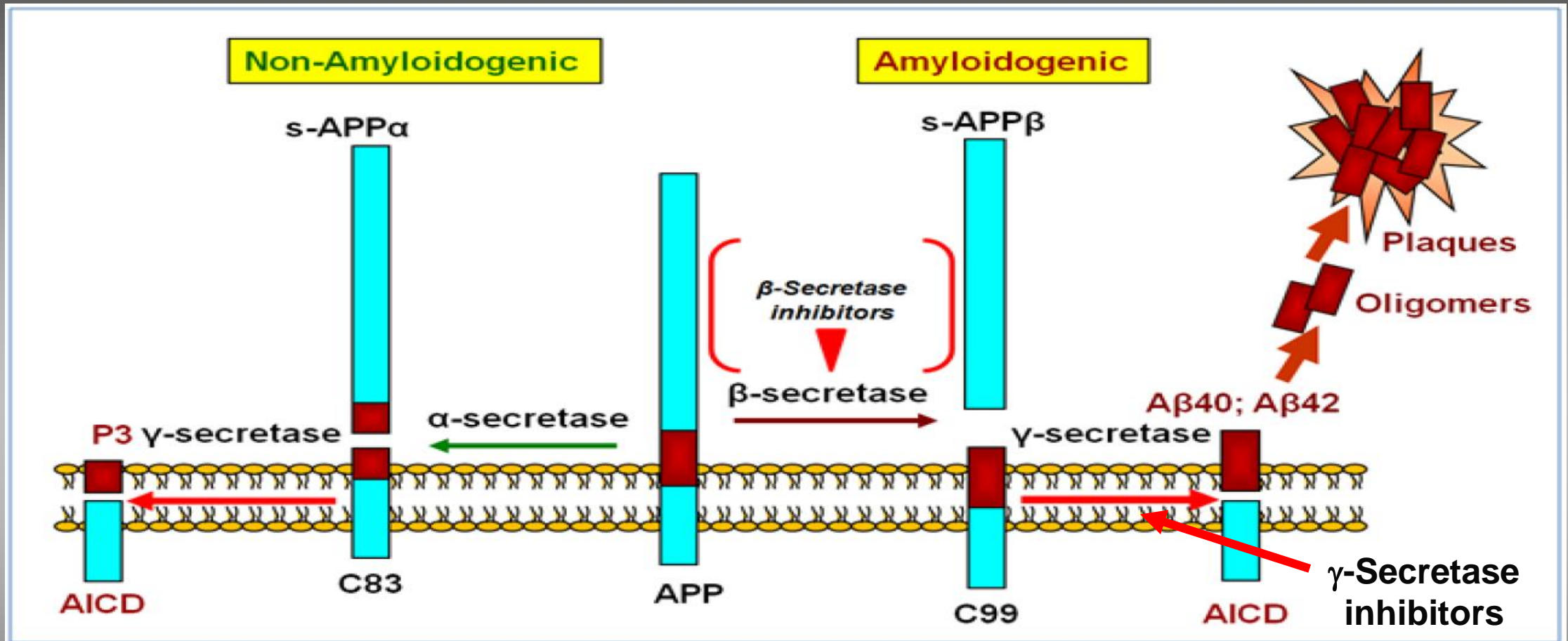
HISTOLOGY



Treatment Approaches for AD

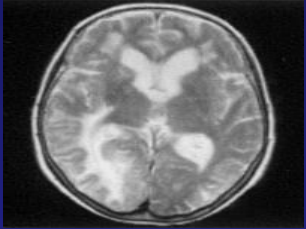


Inhibition of γ - and β -Secretase as a Treatment for AD

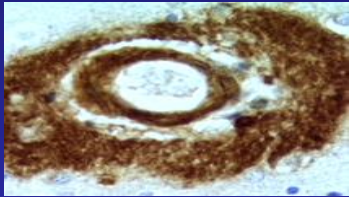


γ - and β - secretase inhibitors have off target substrates such as Notch and neuregulin 1, respectively. Notch regulates cell proliferation and differentiation. Neuregulin regulates myelination of neurons. There have been significant side effect issues. BACE inhibitor trials are on-going.

Problems to Overcome for Developing a Successful AD Vaccine



For immunotherapy approaches need to overcome tolerance without inducing excessive cell mediated inflammation.



Effectively reduce Vascular Amyloid without inducing hemorrhages or ARIA.



Address tau related pathology in addition to A β deposition concurrently



Specifically target the most toxic oligomeric species of A β and tau

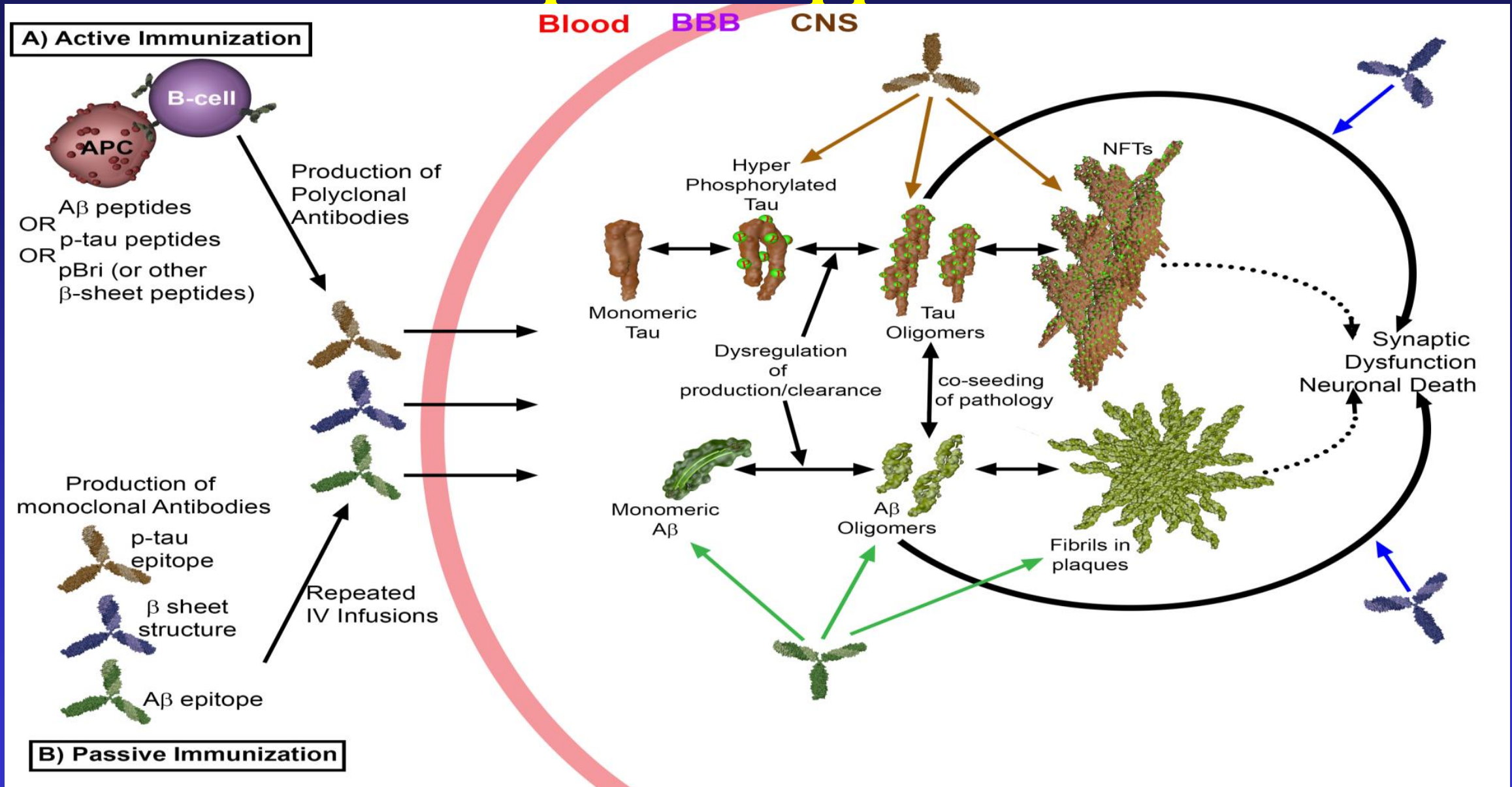


Targeting of Concomitant pathologies: α -synuclein and TDP-43 aggregation

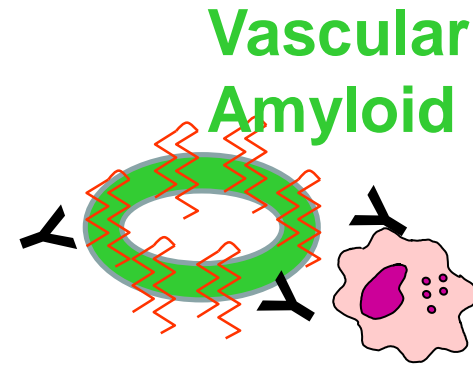
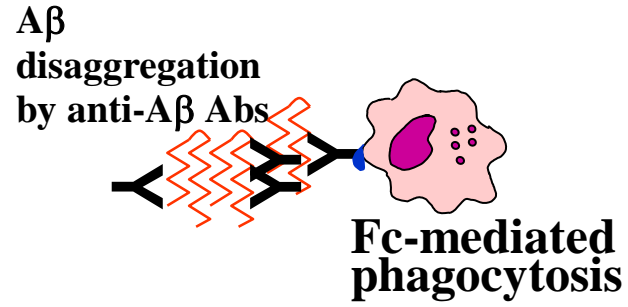
Past Vaccination Clinical Trial Failures

Name	Active or Passive	Epitope	Phase	Company
ACC-001 QS-21 (NCT00960531)	Active	N-terminus	II	Wyeth & Elan
Affitope AD01 (NCT00711139)	Active	N-terminus	I	Affiris
CAD-106 (NCT01097096)	Active	N-terminus	II	Novartis
Bapineuzumab	Passive	N-terminus	III	Wyeth & Elan
Solenazumab (LY2062430)	Passive	Middle	III	Eli Lilly
PF-04360365 (RN-1219)	Passive	C-terminus	II	Pfizer & Rinat Neuroscience
Gantenerumab/ R1450 /RO4909832	Passive	N-terminus and internal	I	Hoffman-LaRoche & MorphoSys
V950	Passive	N-terminus	I	Merck
GSK933776A	Passive	not published	I	GlaxoSmithKline
Crenezumab	Passive	not published	II	Genentech

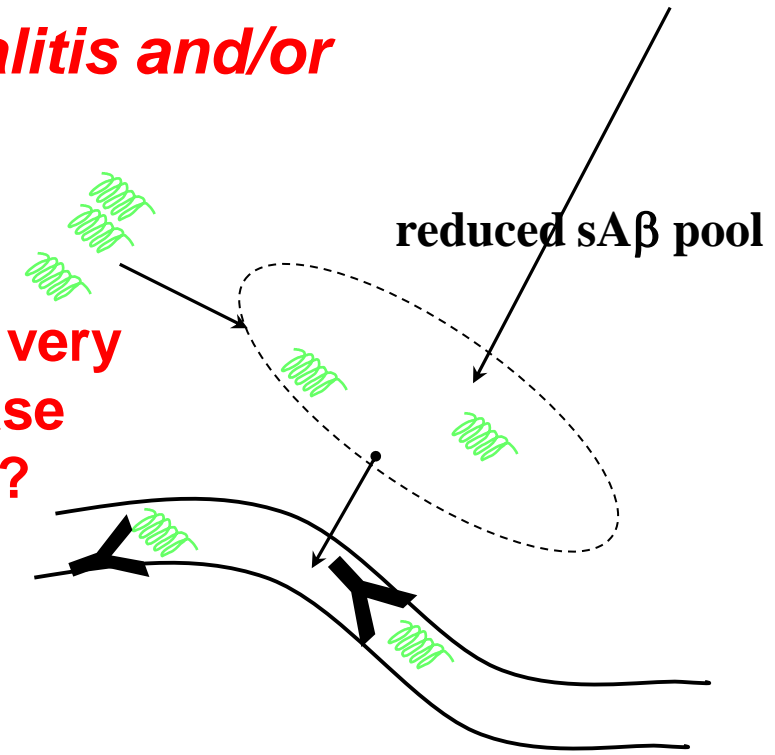
Immunotherapeutic Approaches for AD



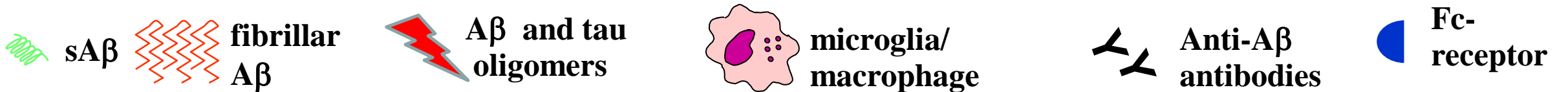
(A) CNS fibrillar amyloid clearance with anti-A β antibodies



(B) fibrillar amyloid clearance via a “peripheral sink” with anti-A β antibodies



Effectively only very Early in Disease Progression?



Early proof of concept for the therapeutic approach, but issues remain

RESEARCH

Alzheimer's hope

An experimental Alzheimer's drug slowed cognitive decline in a small trial, said the drug's manufacturer, Biogen Idec of Cambridge, Massachusetts, on 20 March. Aducanumab targets amyloid- β plaques, high levels of which are found in the brains of people with Alzheimer's disease. After 54 weeks of treatment, patients taking aducanumab showed reduced levels of amyloid- β — the first time an Alzheimer's drug has shown a statistically significant effect. The safety study of 166 patients found the drug to be generally safe, although there were side effects at higher doses. Experts caution that the findings are preliminary.

➔ **NATURE.COM**

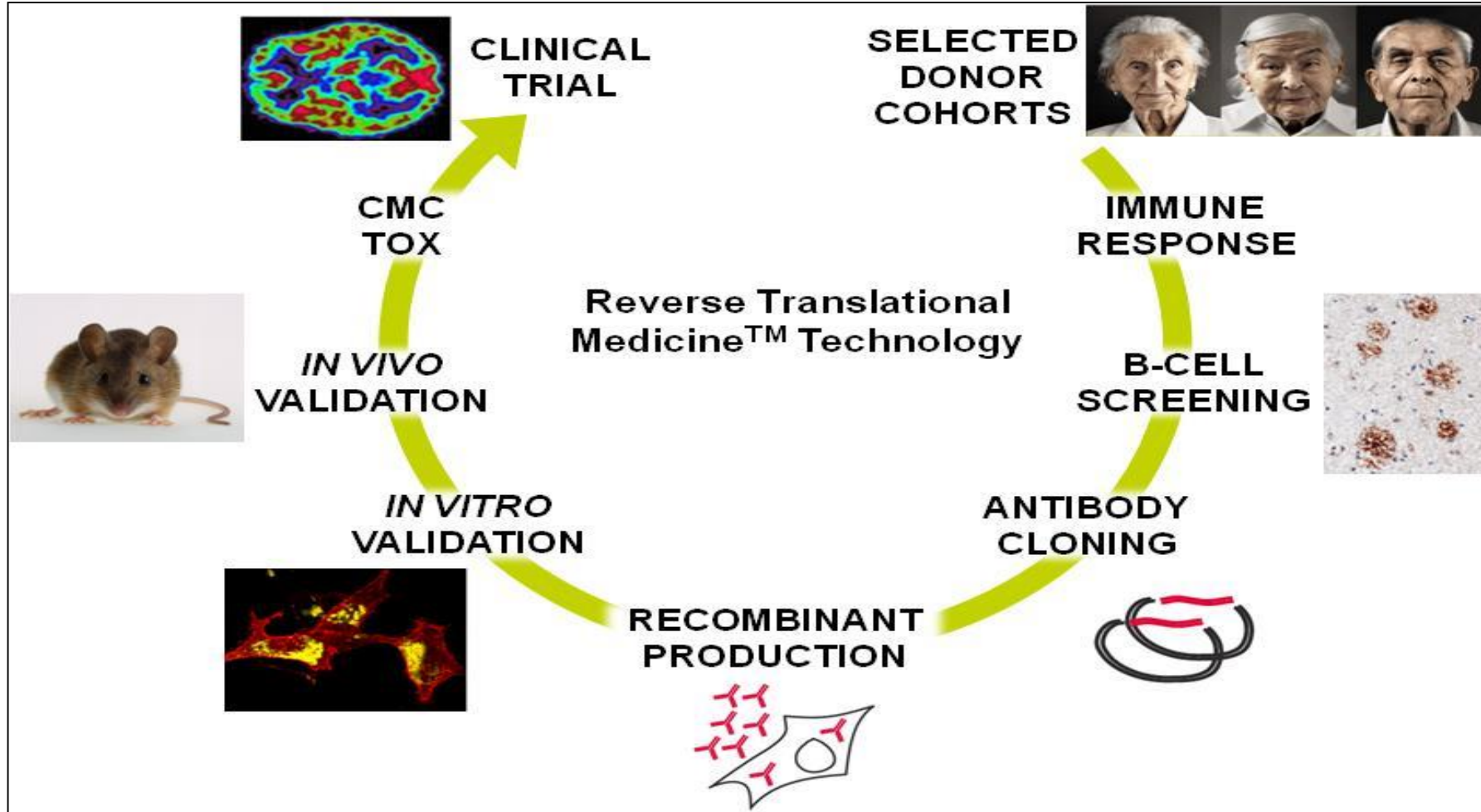
For daily news updates see:

www.nature.com/news

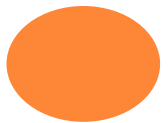
26 MARCH 2015 | VOL 519 |

- Biogen's Aducanumab showed improvement in objective biomarkers and clinical end-points
 - Validates the approach of targeting aggregated A β
- However, major issues remain
 - It is associated with significant side effects (ARIA) due to non-selective targeting of both fibrillar and oligomeric A β

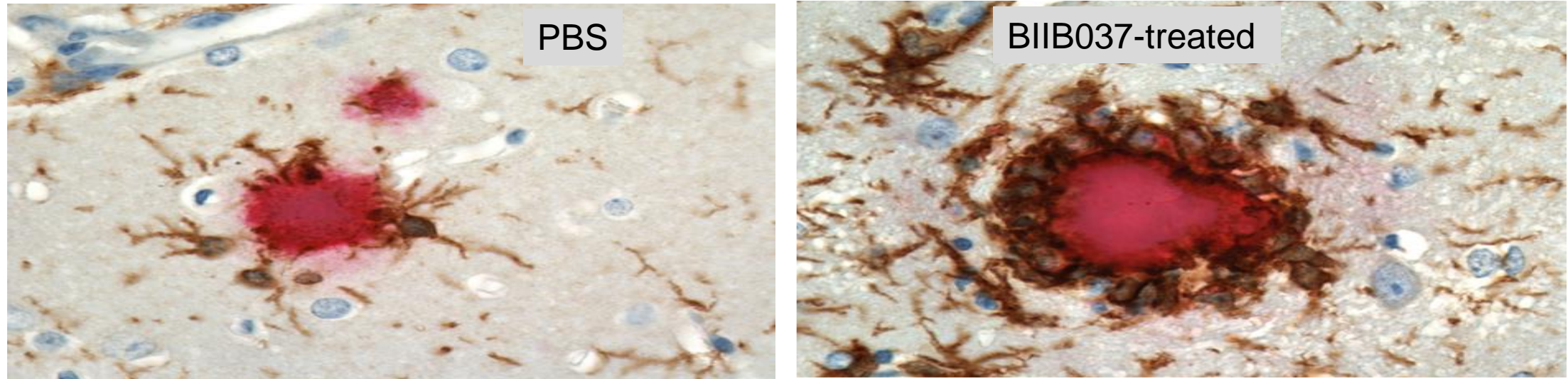
Aducanumab (Biogen) is a human IgG1 anti-A β monoclonal antibody



Aducanumab
Is derived from
a naturally
occurring
antibody
isolated from
human memory
B cells



Microglia-mediated clearance of amyloid plaques



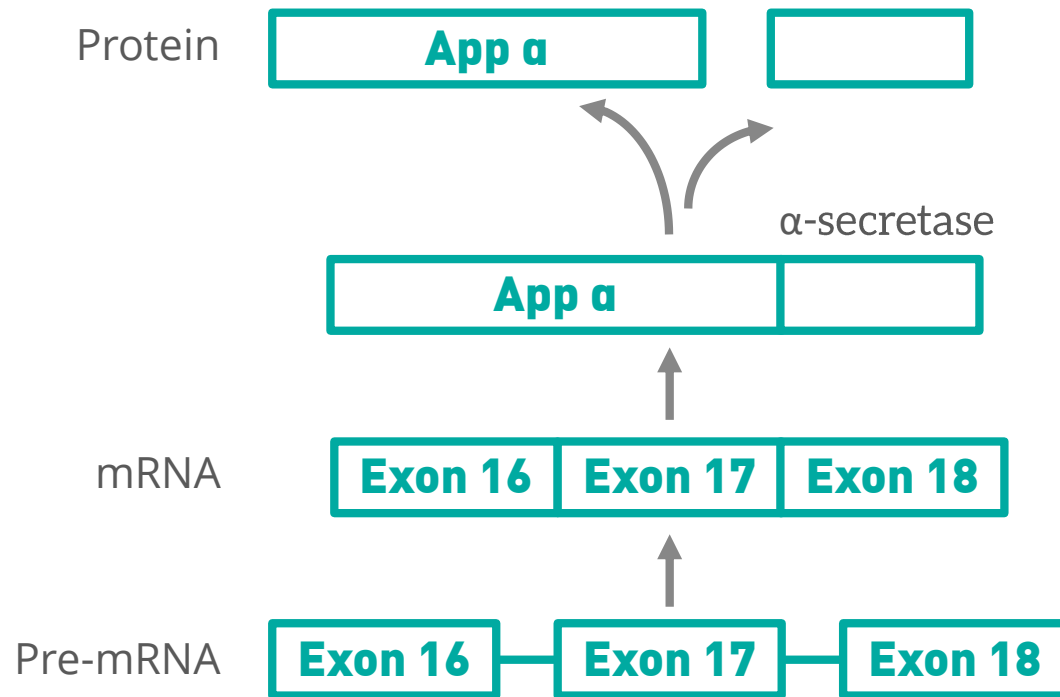
- Immunostaining of Tg2576 mouse brain sections demonstrating recruitment of microglial cells around the parenchymal amyloid plaques upon BIIB037 treatment

Promise from the Adcanumab (Biogen) Trial ?

- The 3 and 10mg/kg doses of Aducanumab produced significant improvements in MMSE in the Phase 1b trial, in association with amyloid burden reduction on PET as reported at the AD/PD meeting in March 2015.**
- However the 6mg/kg dosage failed to show clinical benefits as reported at the AAIC meeting in July 2015.**
- The incidence of ARIA-edema (ARIA-E) was high at 5%, 43%, 55% in the 1-3, 6 and 10mg/kg, respectively in apoE4 carriers and 9%, 22% and 17% in the apoE4 non-carriers**

QRX-203 for Alzheimer's disease

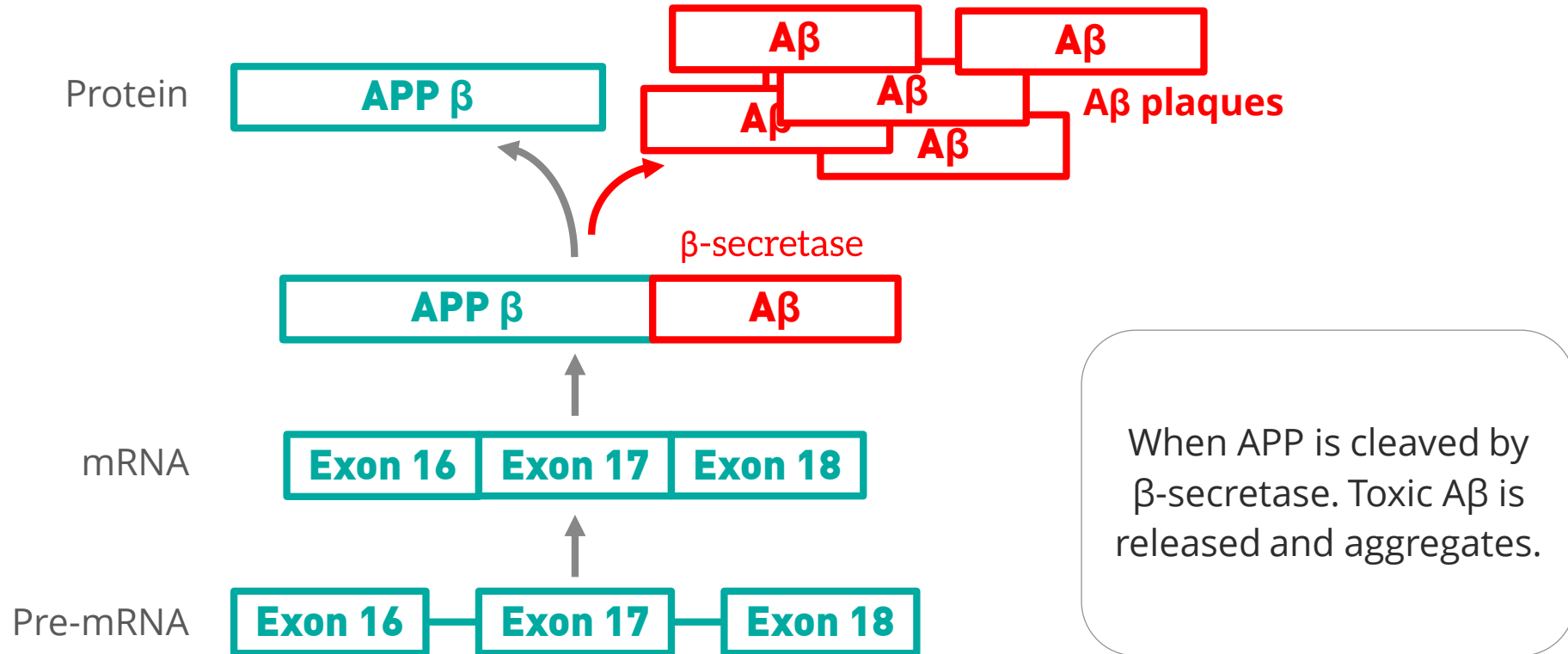
APP processing: Non-Amyloidogenic pathway



The "healthy" cleavage of APP is by α -secretase

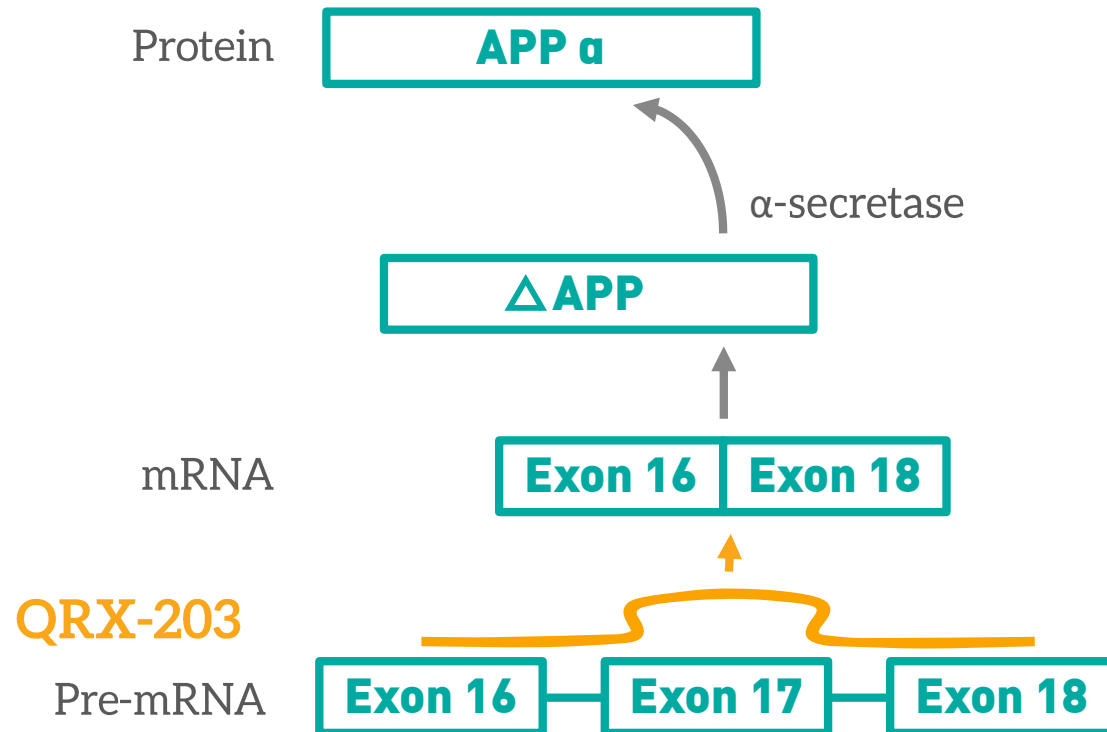
QRX-203 for Alzheimer's disease

APP processing: Amyloidogenic pathway



QRX-203 for Alzheimer's disease

Modulates RNA and prevents A β formation





ProQR R&D DAY

March 14, New York



&



Aknowledgements



The QR-010 clinical program has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633545



CF Foundation



LUMC



Radboud

Questions from the audience





**IT'S IN
OUR RNA**